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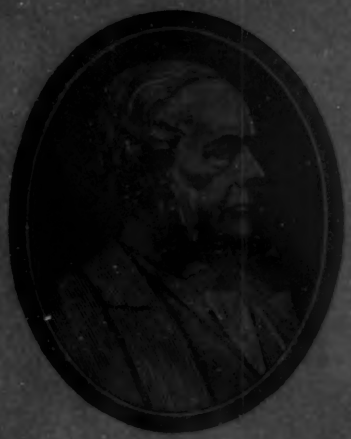

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The British Journal of Surgery

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THE
BRITISH JOURNAL OF SURGERY

VOL. XLII JANUARY, 1955 No. 174

SOME USES OF AN ISOLATED LOOP OF ILEUM IN GENITO-URINARY SURGERY

BY L. N. PYRAH AND F. P. RAPER

THE DEPARTMENT OF UROLOGY, UNIVERSITY OF LEEDS, LEEDS GENERAL INFIRMARY, AND ST. JAMES'S HOSPITAL, LEEDS

ANATOMICAL AND PHYSIOLOGICAL CONSIDERATIONS

ANATOMICALLY the lower ileum is singularly convenient for incorporation into the urinary tract. It has an excellent blood-supply arranged in arcades, the transverse part of which can be divided without impairing the vitality of the gut; the ileal mesentery is in effect a long pedicle which allows the ileum to lie without tension in any part of the pelvis. Its peristaltic contractions are vigorous and continue to act even when a segment of the ileum is isolated. Its secretive and absorptive properties must be carefully considered if it is to be used to transport urine. In the lowest part of the ileum enzyme secretion is almost certainly slight. A considerable quantity of mucus is produced, especially if the bowel is irritated; when the ileum has been incorporated into the urinary tract, this secretion of mucus has occasionally led to trouble, for it may conglomerate to form a mass sufficiently solid to cause obstruction (Tasker, 1953). It is possible that periodic alkalinization of the urine may prevent the accumulation of masses of mucus.

Absorption is the main function of the lower ileum and it is desirable to know what substances are absorbed by a loop of ileum if it is constantly filled with urine. Animal experiments by Steinke (1909), Baird, Scott, and Spencer (1917), Hinman and Belt (1922), and Bollman and Mann (1927) showed that transplantation of the ureters to *intact* small intestine or colon usually led to the death of the laboratory animal. Matsumoto (1938) and Mersheimer, Kolarsick, and Kammandel (1951) showed that in dogs, when the ureters were transplanted to an isolated short segment of small bowel, one end of which was exteriorized, the only blood chemical upset was a slight rise in non-protein nitrogen in the first post-operative week. McLean and Fais (1952) substituted the whole of one or both ureters in dogs by a segment of ileum with ileovesical anastomosis and noted no significant changes post-operatively in the plasma-chloride or carbon-dioxide-combining power. Similar results were obtained in dogs by Davids and Lesnick (1953) and by Annis (1953).

Tasker (1953) reported the construction of an opened loop of ileum and its insertion as a flat graft into the dog's bladder. He then studied the blood electrolyte concentration in two dogs before and after the operation and with and without catheter drainage of the enlarged bladder; no significant changes were noted. He also analysed specimens of venous blood draining from the graft when the bladder was filled with urine, and compared this analysis with that of blood from a systemic vein. Satisfactory specimens were collected from three dogs, and all showed a significantly high quantity of potassium in the blood coming from the graft. The figures also suggested that potassium absorption might run parallel to its concentration in the urine. There was no significant absorption of sodium or chloride.

Some studies on the absorption of potassium from a loop of ileum are reported elsewhere in this issue (Pyrah, Care, Reed, and Parsons, p. 357), and these suggest that the migration of potassium between lumen and blood is dependent upon both the potassium concentration of the fluid in the ileum and the rate at which perfusion takes place. When the potassium concentration of this ileal fluid is less than three times that in the relevant plasma, the net movement of potassium ions is from blood to lumen, rather than the reverse, which occurs with the use of an ileal fluid more concentrated in respect to potassium and therefore more like urine. The excretion of potassium into the lumen was found to be greater at slower rates of perfusion.

Despite these experiments suggesting that an ileal loop may absorb an excess of potassium from urine, there have been few clinical reports of such chemical imbalance occurring in patients who have had an ileal loop incorporated in some part of the urinary tract. Tasker (1953) reports a patient upon whom Mr. J. C. Anderson had performed an ileocystoplasty for a contracted bladder and who died on the twelfth post-operative day with a flaccid paralysis which may have been due to potassium intoxication. Bricker (1952) and Wilson (1953), however, have each reported a patient who developed hyperchloræmic acidosis following the creation of an ileal bladder. Bricker's patient with hyperchloræmic acidosis developed a bilateral hydronephrosis of severe degree post-operatively which required further operation and which may have partly accounted for the chemical imbalance. He also noted that "several" patients who had "ileal

bladders " created after a total pelvic clearance, had a suggestive elevation of plasma-chloride but without depression of the bicarbonate. Also four of his patients, three of whom died, had post-operative convulsions the cause of which was not discovered, but it might well have been due to a chemical imbalance, perhaps an excess loss of sodium. Eiseman and Bricker (1952) studied electrolyte

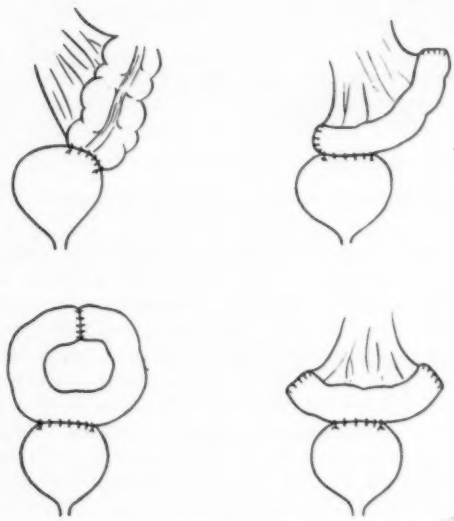


FIG. 389.— Diagrams of different types of intestino-cystoplasty.

absorption in a series of these patients who had ureteral transplants into an isolated segment of small intestine and they found that urea and chloride were absorbed when present in the concentrations usually found in urine. They therefore recommend keeping the urine dilute and the loop of ileum short.

Wilson's (1953) patient had a pelvic evisceration for a carcinoma of the pelvic colon which had involved the bladder, the ureters being transplanted into an isolated 6-in. loop of ileum. Urine drained satisfactorily and the patient was well until the fifteenth day, when he became drowsy and was found to have a hyperchloræmic acidosis. This was corrected with sodium citrate and he then made a steady recovery. The interest lies in the fact that the acidotic phase seems to have lasted for only two to three weeks, for he needed no further sodium citrate after leaving hospital, and Wilson suggests that the function of the ileal mucosa in the early post-operative period may have contributed to the sodium deficit and that in the later stages the activity of the mucosa changed and no longer modified the urine.

To summarize these experiments and chemical investigations, it seems quite possible to use a loop of ileum to transport urine but there may be a tendency for potassium, urea, and chloride to be reabsorbed from the urine in such a loop. There may also be produced a form of acidosis due to an excessive loss of sodium, but this may be only a temporary phenomenon. For many years in surgical practice small intestine has been occasionally incorporated into some part of the human urinary tract and the overall impression from the reports is that chemical imbalance is much less common following these operations than when both ureters have been transplanted to the functioning colon.

PREVIOUS REPORTED CASES

1. To Enlarge the Bladder : Ileocystoplasty. —The first operation using intestine to enlarge the bladder was done by von Mikulicz in 1898. Shoemaker (1909), desiring to rest a contracted bladder which was probably tuberculous, implanted the sole remaining ureter to a loop of ileum, the lower end of which was brought out through the abdominal wall. When the bladder had healed, the ileum was detached from the abdominal wall and anastomosed to the bladder. During the next twenty years or so in the European literature there followed a number of reports of single cases in which some isolated part of the alimentary tract had been anastomosed to the bladder. Sometimes an isolated length of ileum was used, sometimes a short segment of the pelvic colon or the ascending colon and cæcum. Sometimes one end of the isolated segment was anastomosed to the bladder and the other end was closed ; sometimes the centre of the segment was anastomosed to the bladder and both ends were closed. Scheele (1941) anastomosed the centre of an isolated loop of ileum to the bladder and joined the ends of the loop together, producing a continuous ring of ileum anastomosed to the dome of the bladder (*Ringplastik*). These different methods are best comprehended in the diagrams (*Fig.* 389).

Scheele (1941) in a monograph was able to collect 20 such cases, of which 10 were of the so-called " *Ringplastik* " type. The authors quoted by Scheele and the types of operation they described are as follows (Couvelaire, 1950) :—

Ileocystoplasty :—
- von Mikulicz, 1898
- Rutkowski, 1899
- Kausch, 1907
- Rubritius, 1926

Cysto-coloplasty :—
- Stockel, 1918
- Birnbaum, 1920
- A. Mayer, 1921
- Strazmann, 1924

" *Ringplastik* " :—
- Scheele, 1923
- Sebering, 1932 (2 cases)
- Hulme, 1933
- Goetze, 1933–34–35 (3 cases)
- Friedrich, 1936–37 (3 cases).

Kirschner (1939) described Scheele's operation in his book.

Few other operations were reported until Couvelaire's paper (1950). In a most comprehensive fashion he discusses the different types of bladder and kidney which are found in the tuberculous urinary tract and discusses the logical means of enlarging the small tuberculous bladder and of relieving hydronephrosis. He reviews the past literature, adds one other example of cysto-coloplasty (Gouvea, 1936) and another reported *Ringplastik* (Vuurst de Vries, 1949). He then describes 5 cases of his own which had small, healed, tuberculous bladders. In 3 of these he anastomosed the

isolated cæcum to the bladder, but 2 of these patients died on the second or third day after operation. In the other cystocæcoplasty he first anastomosed the muscular and peritoneal layers of cæcum and the bladder and completed the anastomosis by breaking through the two mucosæ with a resectoscope in the bladder and guided by a light from a cystoscope in the cæcal loop. The opening so made does not seem to have been sufficiently large, for it required to be re-opened two years and nine months later. The other 2 patients had very small bladders and severe hydronephrosis of the sole remaining kidney. After a preliminary nephrostomy he did a ureteroileocystoplasty, making a lateral anastomosis between the ureter and the ileal loop. Both patients were relieved of their frequency.

Cibert (1953) reported that he had done 17 ileocystoplasties and showed the follow-up radiographs of one in which a marked hydronephrosis and hydro-ureter of the sole remaining kidney had returned to normal size two years after the ileocystoplasty. There was also a considerable reduction in the frequency of micturition.

Tasker (1953) reported 1 case in which the bladder had been enlarged by the insertion of an opened loop of ileum. The bladder capacity increased from 6 oz. to 10 oz. and there was very little residual urine.

In a further article Cibert, Durand, Foret, and Soler (1954) state that they have now done 23 ileocystoplasties, and they make further observations on the contracted tuberculous bladder and the causes of ureteric reflux. They draw attention to the fact that in the very small healed tuberculous bladder it is the detrusor muscle which has contracted, whereas the trigone is of normal or even greater than normal size, and the posterior urethra is often dilated. If but one ureter remains, this enters the bladder in its upper corner, and in order to avoid injury to it they suggest that the incision into the bladder for the ileovesical anastomosis should be placed on the side of the bladder opposite to the remaining ureter. They also suggest that what remains of the detrusor muscle should be excised and that the ileal loop should be anastomosed to the more supple and healthy trigone, because they believe that there will then be less chance of the stoma contracting in the future. An excellent group of radiographs show regression of vesicoureteral reflux after ileocystoplasty, and they also demonstrate a reduction in the size of the posterior urethra. There is not yet available a full report on the whole series of cases. In addition to ileocystoplasty for patients with the *very* small bladder, they also recommend the operation for patients with frequency of micturition due to a bladder of a fixed capacity which is less than that of a normal bladder, if there is also ureteric reflux. In these patients they also first do a subtotal cystectomy, removing most of the detrusor; they state that it is too early to estimate the final results.

2. Ileum used to replace the Ureter or Ureters.—The usual indications have been an injury to the ureter or ureters at a point too high to allow re-implantation to the bladder. Such a case was reported by Longuet (1948) in a patient with one ureter injured at a Wertheim's operation. He did a side-to-side anastomosis between ureter and ileal loop, the lower end of the loop being anastomosed to the bladder. Muller (1950), in a patient in whom both ureters had been damaged at a Wertheim's operation, isolated an ileal loop, closed the upper end and anastomosed the lower end to the bladder. The left ureter was anastomosed to the side of the loop, the right ureter being also implanted two and a half months later.

Foret and Heusghem (1953) used a U-shaped loop of ileum, the ureters being anastomosed to the limbs of the U and the centre of the loop anastomosed to the bladder, for a patient with bilateral stenosis of the ureteric orifices. Baum (1954) replaced either a portion or the whole of a ureter in 4 patients. One had an adynamic ureter above an area of narrowing close to the bladder, one had a ureteric stricture following the removal of a stone, one had a stricture of the pelvi-ureteric junction for which two previous operations had been done, and the fourth had bilateral ureteral obstruction by metastatic carcinoma of the cervix. One interesting point is that in the patient with the pelvi-ureteric stricture previous scarring made it impossible to anastomose the ileal loop to the pelvis and it was successfully anastomosed to the greatly dilated lower calix of the kidney. Ortved (1954) reported a patient in whom he had used an ileal loop to replace the lower half of the left ureter which had previously been damaged by manipulation for removal of a stone.

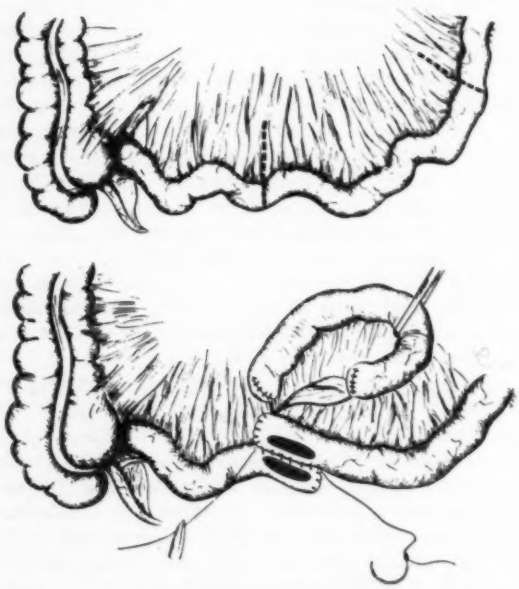
3. Ileum used as a Urinary Reservoir.—In the early attempts to use intestine as a urinary reservoir, use was made of the ileocæcal valve in an attempt to make a continent opening. Usually the lower ileum, cæcum, and ascending colon were isolated and the ureters implanted to the cæcum or ascending colon and the ileal end was then brought through the abdominal wall and catheterized intermittently. Verhoogen (1908) recorded such an operation, but used an appendicostomy for the catheter drainage. This type of operation has been used more recently by Bricker (1950), who used this form of artificial bladder after total pelvic clearance for carcinoma of cervix. He, after trial use of an isolated segment of sigmoid colon or an isolated lower ileum and cæcum drained either via the ileum or through a cæcostomy, came to the conclusion that as none of these produced a continent opening it would be simplest to anastomose the ureters to an isolated loop of small intestine one end of which was brought through the abdominal wall and attach a Rutzen bag to the ileostomy opening. Similar operations have been reported by Annis, Hunter, and Wells (1953) and Wells (1953). Wells favours transplantation of the ureters to an isolated ileal loop after cystectomy rather than the hitherto more usual transplantation to the intact colon. A more ingenious operation using ileum as a reservoir was devised in 1911 by Cuneo, who implanted the ureters into a loop of ileum and joined the lower end of the loop to the anal canal which he approached through a separate perineal incision.

Couvelaire (1951) formed an artificial bladder from a loop of ileum the lower end of which he anastomosed to the prostatic urethra immediately after cystectomy for carcinoma of the bladder. The upper end of the loop was brought through the

abdominal wall and at first kept open. The side of the ileum was anastomosed to the proximal end of the prostatic urethra and both ureters were transplanted into the loop. Eventually, after some unsuccessful attempts, the abdominal opening was closed and micturition then occurred entirely through the urethra. Micturition was produced by straining and by manual pressure over the lower abdomen.

THE PREPARATION OF AN ILEAL LOOP

In the following pages will be described some of the uses we have found for an isolated loop of ileum, and because the method of isolation of the ileal loop is common to all the operations to be described below, it is convenient to discuss this first. Prior to operation the patient has been given a low-residue diet, together with either 5 g. streptomycin in 100 ml. water daily by mouth or 250 mg. aureomycin 4-hourly on the four days before operation. The colon is washed out on the two mornings before operation and an enema given on the evening before operation.



When the abdomen has been opened, a general inspection is made and a suitable coil of bowel in the lowest 3 ft. of the ileum is selected. The bowel must be healthy and must have a mesentery sufficiently long to reach the bladder without tension. The rest of the small intestine is then pushed into the upper abdomen and retained there by moist packs; this procedure is aided by putting the patient in a moderate Trendelenberg position. If the ureters are to be anastomosed to the ileal loop, these are now isolated and prepared. Once this has been done, a more accurate estimation can be made of the length of ileal loop required. At the lower point selected for division of the ileum, which should be about 10 cm. above the ileocæcal valve, the vascular arcade close to the gut is divided between ligatures and the cut is prolonged into the mesentery at right angles to the intestine. The mesentery rarely needs to be cut for a distance exceeding 5 cm., but a second vascular arcade may have to be divided. If the mesentery is fatty the vessels can be readily identified by holding a lamp behind it. A similar opening is then made into the mesentery the required distance above the first. The base of the mesentery to the isolated loop should be as wide as possible in order to minimize the chance of rotation of the vascular pedicle. The intestine is then divided between clamps at the two selected places and continuity of the intestine restored by lateral or end-to-side anastomosis either in front of, or behind, the pedicle of the isolated loop, whichever seems the most convenient when the final position of the loop is considered. The aperture between the anastomosis and the mesentery of the loop lying in front of it is obliterated by a few interrupted sutures between the anterior leaf of the mesentery of the loop and the back of the anastomosis, in order to minimize the risk of an intestinal strangulation (*Fig.* 390).

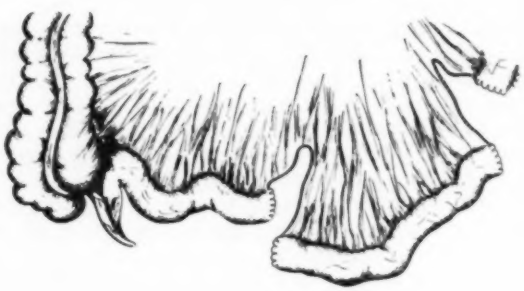


FIG. 390.—Steps in the preparation of an ileal loop.

It has been the practice of one of us (L. N. P.) to irrigate the isolated loop with a stream of sterile saline. A quantity of bile-stained fluid and debris is thus evacuated. The further preparation of the loop then depends upon the use to which it is to be put. For one type of ileocystoplasty the two ends are closed and the anastomosis to the bladder is made at the centre of the loop. For another method of ileocystoplasty, the loop is completely opened along its antimesenteric border and bleeding points are ligatured. For the operations involving the ureters, both ends of the loop are left open.

When the ureter has to be anastomosed to an ileal loop we have used a variety of methods, but have avoided a direct type of anastomosis where the loop was to be attached to the bladder, since there is a considerable rise of pressure in the loop when the bladder contracts and this might be transmitted to the kidney by such an anastomosis.

1. ILEAL LOOP USED TO ENLARGE THE BLADDER

A. ILEOCYSTOPLASTY WITH A CLOSED LOOP

Indications.—This may be used to enlarge any form of contracted bladder which is free from infection. In this series, three patients had a form of interstitial cystitis for which many other methods of treatment had been used unsuccessfully. One

other patient had a contracted bladder following tuberculosis, but the operation has not been considered advisable for patients who still have evidence of active tuberculosis in the urinary tract. The open type of loop may be used to enlarge the bladder after a large partial cystectomy.

Operation.—A right paramedian incision is satisfactory and it must reach to the pubic symphysis. A loop of ileum 20 cm. long is prepared as described previously and both ends are closed. A transverse incision is then made through the peritoneum over the posterior wall of the bladder about 5 cm. below the vault. The peritoneum is dissected upwards and downwards from the incision, thus exposing a wide area of the posterior wall of the contracted bladder. An anastomosis is then made with as large an opening as can be obtained, considering the size of the bladder, between the centre of the loop of ileum and the posterior wall of the bladder,

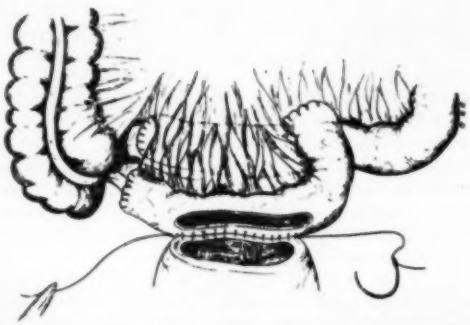


FIG. 391.—Operation of ileocystoplasty showing the form of the anastomosis.

after the manner of a gastro-enterostomy. Two rows of continuous sutures are used, the first being between the seromuscular layer of the intestine and the bladder muscle and the second through the whole thickness of the intestine and the mucosa together with about half the thickness of the bladder muscle (*Fig.* 391). The inner stitch is so placed as to bring the two mucous membranes into careful apposition. The peritoneum, previously reflected from the bladder wall, is then sutured to the intestine in such a way as to make the anastomosis lie outside the peritoneal cavity. The abdomen is closed, leaving a tube into the cave of Retzius ; an indwelling catheter is placed in the urethra. Post-operatively, penicillin and streptomycin have been given. The abdominal drainage-tube is removed on the third or fourth day and the urethral catheter on the tenth day.

CASE REPORTS

Case 1.—E. P., female, aged 38.

HISTORY.—Eighteen years of urinary symptoms commencing with recurrent attacks of cystitis for the first five years were followed by gradually increasing frequency of micturition and suprapubic pain. She came under the care of one of us (L.N.P.) in 1949. Between 1949 and January, 1952, the frequency had been half-hourly to one-hourly in the daytime and eight to ten times at night.

INVESTIGATIONS.—The urine on some occasions contained pus cells and *B. coli*, but was often sterile. Pyelograms showed normal kidneys. On cystoscopy, on most occasions there were localized red patches of inflammation on the left lateral wall and vault of the bladder suggesting interstitial cystitis. The bladder capacity varied between 3 oz. and 6 oz.

She received treatment at various times during the three years either by light diathermy to the inflamed areas or by distension of the bladder. None of these treatments produced more than transient improvement and the distressing frequency always returned.

AT OPERATION (L. N. P.).—On Jan. 3, 1952, ileocystoplasty was done as described above. The urethral catheter was removed on the tenth day. Convalescence

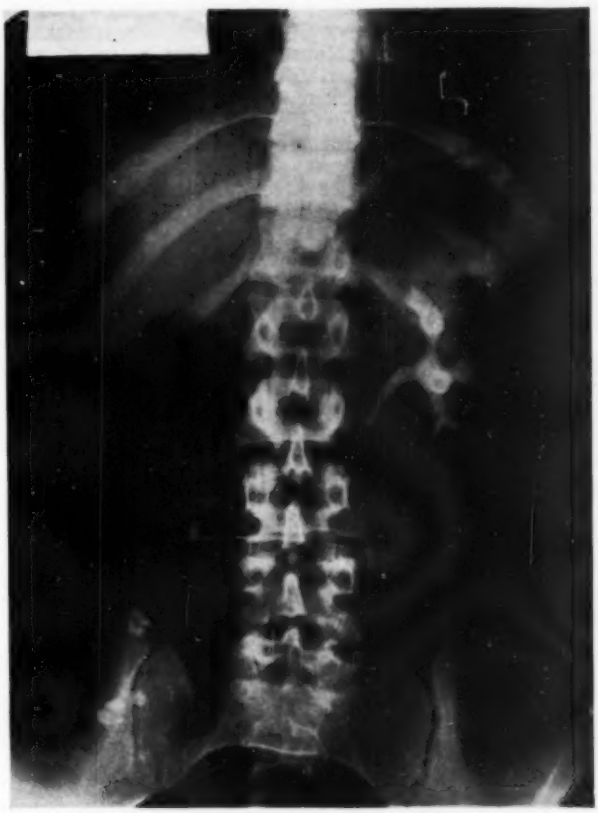


FIG. 392.—Intravenous pyelogram in *Case* 2 Although the bladder is contracted there is no associated hydronephrosis.

was without complication, there was no leakage of urine from the wound and no wound infection.

RESULT.—Frequency of micturition has been reduced to three-hourly or four-hourly by day and occasionally once at night. Micturition was at first slower than normal. Intravenous pyelograms show that the kidneys are still normal and repeated examinations of the urine show that it is sterile.

Case 2.—V. B., female, aged 30.

HISTORY.—The patient had had bilateral apical pulmonary tuberculosis for some years and was still under treatment by artificial pneumothorax. On June 2, 1948 she had a right nephro-ureterectomy for tuberculosis of the right kidney at another hospital. She was first seen three years after the nephrectomy, when she complained of frequency of micturition, hourly by day and six or seven times at night.

INVESTIGATIONS.—The urine contained an occasional pus cell, was sterile on culture, and culture and guinea-pig tests for tubercle bacilli were negative. The radiograph of the chest showed tubercle of both apices. Intravenous pyelograms showed that the left kidney and ureter were normal and there was no hydronephrosis (*Fig.* 392); the bladder shadow was small and round. On cystoscopy

the capacity of the bladder was 3½ oz. The mucosa was healthy and smooth and there was nothing to suggest active tuberculosis. The left ureteric orifice was normal and the efflux was clear.

AT OPERATION (L. N. P.).—On March 6, 1952, ileocystoplasty was performed. When the ileum was inspected, a solitary, tuberculous ulcer readily recognized by the tubercles on its peritoneal aspect, was found 5 in. from the ileocæcal valve. No other doubtful areas were seen. When the ileal loop was prepared, the ulcer with a wide margin of ileum on either side was resected. In other respects the operation was similar to that in *Case* 1.

MICROSCOPICAL REPORT.—The ulcer in the ileum was shown to be tuberculous. A small piece of bladder wall removed at operation showed that the muscle bundles were healthy but were intersected by broad bands of cellular fibrous tissue partially infiltrated by round cells. There was nothing to suggest tuberculous infection.

POST-OPERATIVE COURSE.—This was normal. There was no ileus and no wound infection. The drainage-tube down to the bladder was removed on the fourth day and there was no urinary leak. The catheter was removed from the urethra on the tenth day. A ninety-day course of streptomycin (1 g. per day) with P.A.S. (12 g. per day) and a period of sanatorium treatment were given after operation.

RESULT.—Frequency is two-hourly to three-hourly in the daytime and once and occasionally twice at night. Her general condition is good, though she still receives treatment by artificial pneumothorax. There has been nothing in her symptoms to suggest any further extension of the intestinal tuberculosis. The bladder urine is usually clear to naked-eye inspection, but occasionally there is a faint turbidity and on those occasions there are a few pus cells and a moderate growth of *B. coli*. There has been no clinical cystitis. Intravenous pyelograms thirteen months after operation show no evidence of hydronephrosis of the remaining kidney; the cystogram shows a wide opening between the bladder and the intestinal loop.

Case 3.—S. E. H., female, aged 62.

HISTORY.—She had several attacks of cystitis twenty-five years ago followed by twenty years of persistent frequency of micturition. For the last five years this frequency had been half-hourly to one-hourly in the daytime and eight to ten times at night. During the last two years she had had various treatments, including stretching the bladder, but there had been only transient improvement.

INVESTIGATIONS.—The urine contained no pus and was sterile. The blood-urea was 45 mg. per cent. An intravenous pyelogram showed that both kidneys were normal, but the bladder was small and round. On cystoscopy the capacity of the bladder was 3 oz., but there was no cystitis and the ureteric orifices were normal.

AT OPERATION (L. N. P.).—On May 10, 1952, ileocystoplasty as described above was carried out. The bladder wall was very thick and there was a dense layer of fibrous tissue in the submucosa. *Cases* 1 and 2 had shown traces of this same layer.

POST-OPERATIVE COURSE.—There was a slight leakage of urine from the abdominal wound between the sixth and tenth day, otherwise progress was normal. In spite of the leakage there was no wound infection. The urethral catheter was retained until the fourteenth day.

RESULT.—The patient now passes urine every two to three hours in the daytime and only occasionally in the night. Her general condition has improved. Catheter specimens of urine are usually sterile, but occasional specimens have shown a few pus cells and given a growth of *B. coli*. The upper urinary tract remains normal.

Case 4.—E. H., female, aged 55.

HISTORY.—For five years she had had pain in the suprapubic region and over the sacrum, together with frequency and urgency of micturition, the frequency being for long periods as often as one-hourly during the day and night. There was only occasional scalding on micturition. Physical examination was normal, but the patient was obese.

INVESTIGATIONS.—On most occasions she had a sterile pyuria, but repeated examinations for tubercle bacilli over a period of two years were all negative. The pus was only detectable on microscopical examination. Intravenous pyelograms showed that the kidneys and ureters were normal. On cystoscopy on several occasions the bladder capacity was 5 oz. and there were three small, shallow ulcerated areas of mucosa on the posterior wall of the bladder from which drops of blood oozed when the bladder was distended. The appearances were typical of an interstitial cystitis.

She was treated by various antibiotics and sulphonamides, and light diathermy to the ulcerated area on three occasions. The longest period of freedom from symptoms resulting from this treatment was one month. In February, 1954, the frequency had become half-hourly by day and night and there were no pus cells in the urine.

AT OPERATION (F. P. R.).—On April 5, 1954, ileocystoplasty was performed. This was carried out as previously described, a biopsy being taken from the ulcerated area at the time of operation.

The only post-operative complication was the development of a hæmatoma in the abdominal wall. There was no leakage of urine.

MICROSCOPICAL EXAMINATION.—The portion of the bladder from the ulcerated area showed that there was very little bladder epithelium; the bladder wall was œdematous and there was an increased amount of fibrous tissue amongst the muscle-bundles.

RESULT.—It is only three months since the operation but her frequency of micturition has been two-hourly to three-hourly. Sometimes she passes urine only once at night. The flow of urine was slow in the first few weeks after operation.

B. ILEOCYSTOPLASTY WITH AN OPEN LOOP

Indications.—This operation may be used to enlarge any form of contracted bladder and it is probably the most convenient type of ileocystoplasty to use in order to enlarge the bladder immediately after a large partial cystectomy.

The loop is prepared in the usual way, but both ends are left open and it is divided completely along the antimesenteric border (*Fig.* 393). The bleeding points are ligated. In this series only one patient has been treated with this form of ileocystoplasty and details of the operation are given in the following case report.

Case 5.—H. C., female, aged 65.

HISTORY.—The patient complained of intermittent hæmaturia for seven months. In the last month the bleeding had been profuse and was associated with frequency and slight discomfort on micturition. The patient was thin and frail and her general condition was not good. The kidneys were not palpable.

INVESTIGATIONS.—The urine contained pus cells and gave a growth of *B. coli*. The blood-urea nitrogen was 23 mg. per cent. Intravenous pyelograms showed normal kidneys. On cystoscopy a malignant ulcer was seen on the right side of the bladder which came close to the right ureteric orifice and also close to the bladder neck. It was 4 cm. in diameter. A biopsy showed that it was a poorly differentiated spheroidal-celled carcinoma. On bimanual examination there was a mobile, firm swelling in the region of the right side of the bladder.

In view of the patient's age and general condition, it was decided to explore the bladder with a view to doing

a partial cystectomy, the growth being too large to be suitable for radon seed implantation.

At Operation (L. N. P.).—On Nov. 5, 1952, the bladder was exposed extraperitoneally through a suprapubic incision and was mobilized so as to free the growth, which was then found to be somewhat larger than had been estimated. Almost the entire right half of the bladder was removed including the right ureteric orifice. The right ureter was re-implanted into the remaining portion of the bladder. It was considered that a repair of the bladder would result in a very small organ and it was therefore decided to enlarge the bladder with an open loop of ileum, which was prepared as described above. It was united to the bladder by two layers of sutures, the deepest part of the anastomosis being done first (*Fig.* 393). The peritoneum was then closed in such a way as to leave the ileal graft outside the peritoneum and the wound was closed leaving a drainage-tube down to the area of the anastomosis. The bladder was drained by a urethral catheter.

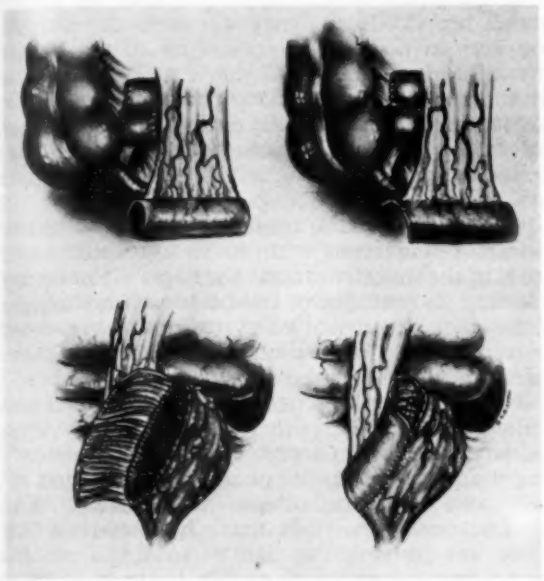


Fig. 393.—Operation of ileocystoplasty, using the open type of loop (*Case* 5).

Subsequent Course.—There was a slight leakage of urine from the fourth to the tenth day, but the patient died from pulmonary embolism on the fourteenth day.

DISCUSSION ON THE OPERATION OF ILEOCYSTOPLASTY

1. The Operation.—Ileocystoplasty is a major surgical procedure carrying with it the risks of a small-intestine anastomosis as well as those of the anastomosis of the loop to the bladder. By using modern methods of reducing the intestinal bacteria before operation and of limiting infection generally in the post-operative period, the procedure has been very well borne. In this short series no complications of ileus or wound infection have occurred. One case succumbed to pulmonary embolism. In the third case the temporary leakage of a small amount of urine for a period of four days did not mar the end-results nor prolong the convalescence. There is a theoretical possibility of intestinal obstruction occurring from entanglement of coils of intestine around the loop. It seems probable, since the loop with its mesentery forms a flat sheet of tissue passing downwards from the region of the intestinal anastomosis to the bladder, that coils of intestine can move in front and behind and to either side of the loop,

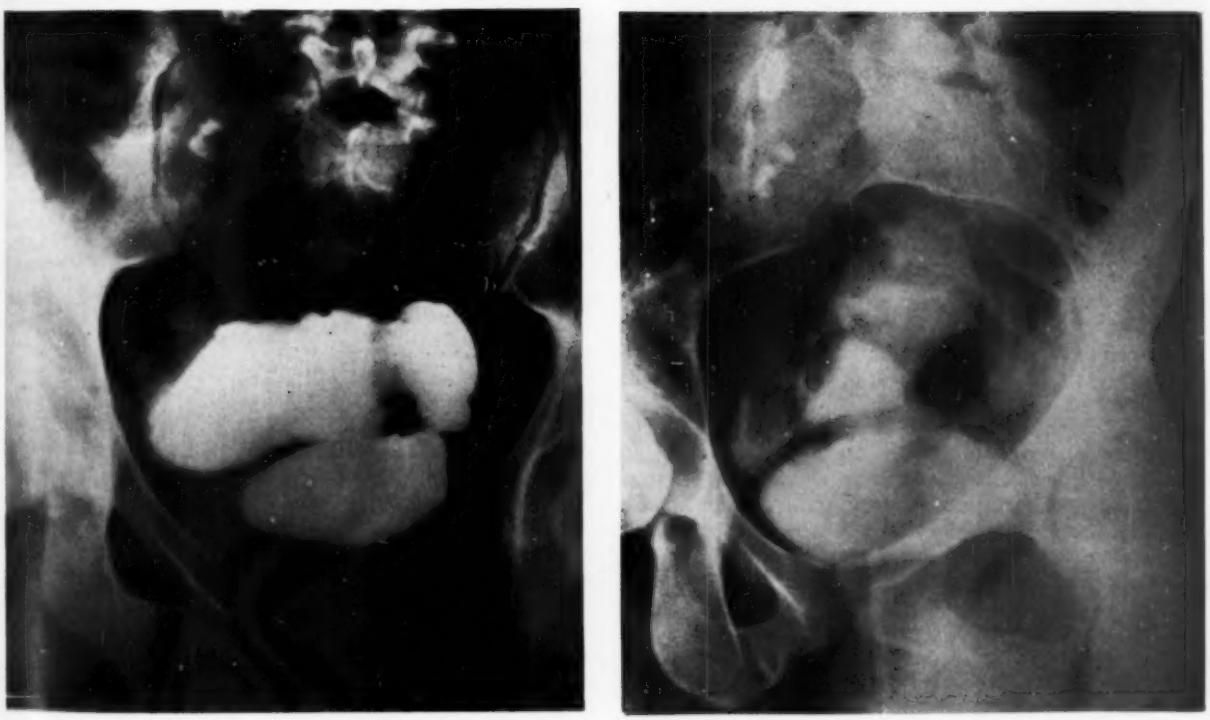


Fig. 394.—Post-operative cystogram after ileocystoplasty (*Case* 2). This shows a wide-open anastomosis between the bladder and the loop and also contraction waves in the ileal graft.

and that, therefore, obstruction apart from casual adhesions is unlikely.

2. Micturition.—For a variable time after operation and in one case extending over a period of some weeks, the act of micturition was not quite normal. The patient had a sense of imperfect emptying of the bladder, which was sometimes relieved by gentle manual pressure by the patient

FIG. 395.—Residual opaque medium in the ileal loop after the bladder has been mainly emptied. This illustrates the biphasic character of the act of micturition in the early post-operative period (*Case* 1).

herself over the lower abdomen to assist evacuation. A few weeks after the operation this difficulty has disappeared.

Radiographic studies of the bladder after ileocystoplasty have been done by filling it with an opaque medium. A good, wide stoma can be seen (*Fig.* 394) and, during screening, contractions in the intestinal loop were observed. A partial explanation for the slow micturition was found in that it seemed that when the bladder contracts some of the opaque medium enters the intestinal loop, which is then stimulated to contract (*Fig.* 395). This biphasic micturition probably accounts for the longer time the patient takes to complete the act. It was found that when the patient spent time over the act, residual urine after micturition was minimal.

3. Infection.—In two of the cases the urine is sterile and in one there is an intermittent but mild *B. coli* infection. Flakes of mucus are always passed, and at first these caused slight alarm to the patients, but repeated examination of the urine showed that the mucus was not the result of infection. There has been no suggestion of the loop itself becoming blocked with inspissated mucus. It would appear that if the anastomosis between the loop and the bladder is sufficiently large, such blockage need not occur.

4. Criticism of this operation may be directed to the supposed similarity between the intestinal loop and an acquired diverticulum of the bladder. The differences between the two conditions are more apparent than real. A diverticulum of the bladder has a fibrous wall, devoid of any muscular coat. The intestinal loop has a muscular wall with an intact nerve-supply, and radiographic studies have demonstrated its power to contract. An acquired diverticulum usually has a narrow opening associated sometimes with an almost sphincter-like action of the muscles around the neck. The opening following ileocystoplasty should always be large and in the cases here reported cystoscopy many months afterwards has demonstrated that it has remained widely patent. A true diverticulum of the bladder is almost always associated with some obstruction at the bladder neck, either from stricture, fibrous bladder neck, or enlargement of the prostate. In the patients for whom the present operation has been done, no such obstruction has existed. While, therefore, it is possible that the intestinal loop, which is certainly a pouch leading off from the bladder, may occasionally lead to stasis of urine, infection, and stone-formation, the theoretical reasons why this may occur appear to be much less cogent than in the case of an acquired vesical diverticulum.

5. The Cystoscopic Appearances of the anastomosis when healing is complete has shown in every case a very satisfactory union between

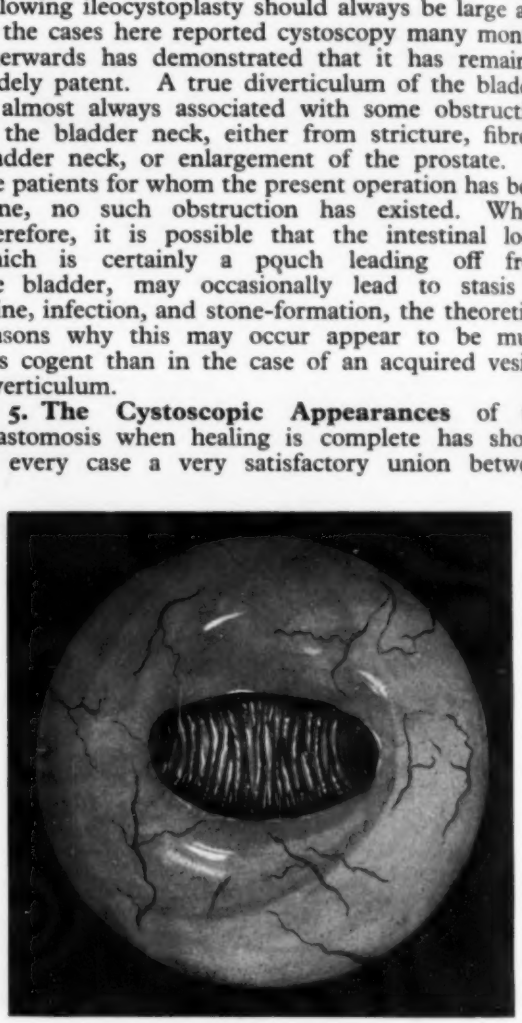


FIG. 396.—Cystoscopic view of the anastomosis after ileocystoplasty (*Case* 1).

the ileal and the vesical mucosæ. A good, wide, opening has been obtained and there has been no granulation tissue at the junction. The folds of the ileal loop have retained their normal appearance and the two horns of the loop can be seen fully patent receding from the bladder (*Fig.* 396). No contraction of the opening has so far been observed.

6. **Electrolyte Absorption.**—Clinical and repeated blood chemical estimations of these patients have not shown the slightest sign of any electrolyte imbalance. Investigations upon this point carried out in the Department are reported in a separate paper in this issue (Pyrah, Care, Reed, and Parsons, p. 357).

7. **Closed or Open Loop.**—*Cases* 1–4 described above show that frequency of micturition due to a contracted bladder can be very satisfactorily relieved by an ileocystoplasty with a closed type of loop. The general health of the patients has been improved probably by increasing their sleeping hours. These women are among our most grateful patients. It is, however, obvious, from a comparison of the ileocystoplasties reported by Couvelaire (1950) and Cibert and his associates (1953, 1954), and those which we report here, that there is a difference in the size of the bladder at the time of the operations. The operations carried out by these surgeons were done for patients with very small bladders ("minuscule [une cerise] ", " cavité vesicale en tête de serpent"), some of whom were completely incontinent, whereas our patients were all continent and had a bladder capacity of 3–6 oz. This may produce some difference in results, for after an ileocystoplasty their patients had bladders 90 per cent of the wall of which consisted of ileum, whereas our patients have bladders at least 50 per cent of the wall of which is still bladder muscle albeit fibrosed, and which will presumably still respond to normal stimuli. We should, therefore, expect some difference in the form of micturition between these groups of cases and perhaps also some difference in the emptying of the loop.

Ileocystoplasty using a closed loop is an easier operation to perform than the attachment of an opened loop of ileum to the partially resected bladder. The chances of a leak at the line of the anastomosis seem to be considerably less with the closed loop than with the open loop. If a ureter has to be re-implanted following a partial cystectomy, and it is at the same time desired to enlarge the resected bladder with a loop of ileum, it is probably best to close the lower half of the cystectomy incision, then to attach one end of the ileal loop to the remainder of the incision in the bladder, and finally to implant the ureter into the other end of the ileal loop.

2. ILEAL LOOP USED TO RE-IMPLANT THE URETERS INTO THE BLADDER

Indications.—A loop of ileum can be used to reconnect the ureter or ureters to the bladder when for any reason the ureter is too short to reach the bladder. Such may be the case following injuries to the ureter or if the ureters have previously been diverted to the skin or colon as a temporary measure.

General Considerations.—If it is required to re-implant only one ureter, the replacement of the necessary segment by a short length of ileum is quite simple. When both ureters have to be re-implanted, we have found it convenient to use the loop in the form of a U and to implant the ureters into each of the limbs and to anastomose the centre of the U to the bladder. The details of this operation are given in the case report.

Case 6.—M. L. D., female, aged 42.

HISTORY.—Following an operation for prolapse in 1944, she developed a large vesicovaginal fistula. Four attempts had been made elsewhere to close the fistula and she was referred with a view to transplantation of the ureters to the colon.

INVESTIGATIONS.—The patient was completely incontinent, having a vesicovaginal fistula which would admit two fingers. Intravenous pyelograms showed normal

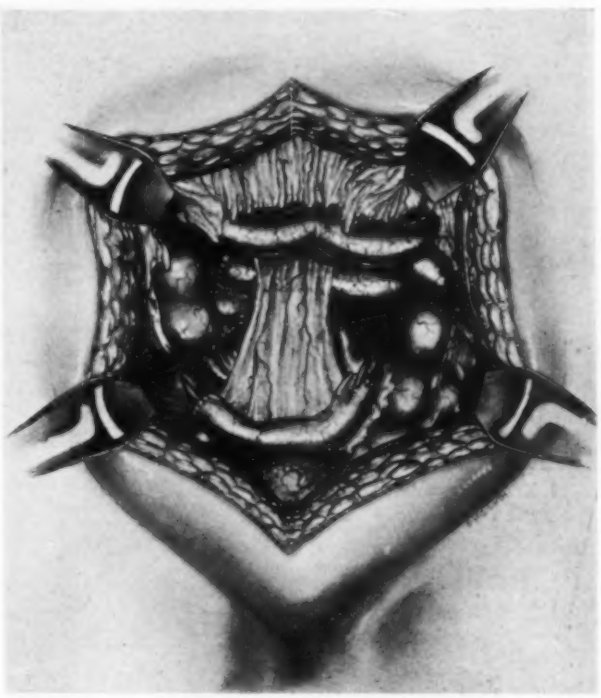


FIG. 397.—Operation of bilateral uretero-ileocystoplasty (*Case* 6).

kidneys. Renal function tests were normal. The blood-urea nitrogen was 25 mg. per cent.

OPERATIONS.—

1. Oct. 5, 1951 (L. N. P.).—Bilateral ureterocolic anastomosis was performed by a direct mucosa-to-mucosa union (Nesbit's method). Recovery was uninterrupted, but before discharge she began to develop a hyperchloræmic acidosis. This was corrected by a low-salt diet and 2 g. sodium bicarbonate daily. In October, 1951, she was re-admitted with an attack of left-sided pyelitis which responded only slowly to treatment. She had three further severe attacks of renal infection in the next twenty months, and it was considered that the vesicovaginal fistula should now be repaired and the ureters re-connected to the bladder before serious renal damage could occur. The fistula was now smaller than when she was first seen, and the bladder now being empty it was thought that operation for closure of the fistula might be successful.

2. April 4, 1953.—Repair of the vesicovaginal fistula by the vaginal route was done by Mr. D. W. Currie. On cystoscopy in September, 1953, the bladder was found to be soundly healed and its capacity was normal.

3. Oct. 15, 1953 (L. N. P.).—The right ureter was reconnected to the bladder using an ileal loop (*Fig.* 397). The abdomen was opened through a right paramedian incision extending from the symphysis pubis to 1 in. above the umbilicus. Some adhesions between coils of intestine consequent upon the earlier transplant operation were divided and the right ureterocolic anastomosis was demonstrated so that it could be severed at a later stage of the operation. A 9-in. loop of ileum was prepared as

previously described. The proximal end of the loop was infolded and closed. An ileocystoplasty, making a large anastomosis in the middle of the loop, was done. The right ureter was divided from its attachment to the colon and was anastomosed to the distal end of the ileal loop using a modified Coffey's technique, the end of the intestine being infolded closely around the ureter. The part of the loop between the bladder and the ureter was attached to the peritoneum of the right iliac fossa by interrupted stitches in order to avoid a possible intestinal obstruction.

FIG. 398.—Intravenous pyelogram, *Case* 7, December, 1950.

FIG. 399.—Intravenous pyelogram, *Case* 7, April, 1952. This shows early hydronephrosis and hydro-ureter.

The patient developed some post-operative ileus which delayed her convalescence, but she made a good recovery. Approximately half the urine was then being passed from the bladder and half per rectum.

4. Jan. 16, 1954 (L. N. P.).—The left ureter was divided at its point of attachment to the colon and the opening in the latter was closed. The left ureter was then placed into the left end of the ileal loop as described above. The left portion of the loop was sutured to the peritoneum of the left iliac fossa, using interrupted stitches. The patient made an uninterrupted recovery.

CONDITION IN JUNE, 1954.—The patient has had no further attacks of renal infection. The urine is sterile and free from pus; it contains flakes of mucus. The blood-chemistry is normal and the blood-urea is normal. Intravenous pyelograms show slight dilatation of the pelvis of the kidney on both sides.

3. ILEAL LOOP USED TO ENLARGE A HEALED CONTRACTED TUBERCULOUS BLADDER AND CORRECT AN INCREASING HYDRONEPHROSIS

An ileal loop may be used at one and the same time to enlarge a contracted bladder and to relieve an associated hydronephrosis of a remaining kidney, resulting from ureteric stricture, reflux, or spasm of the systolic bladder. The following case illustrates such a procedure.

Case 7.—J. M., male, aged 31.

HISTORY.—The patient had a left nephro-ureterectomy for a tuberculous kidney on May. 5, 1950. At that time there was cystoscopic evidence of tuberculosis of the bladder. Following the operation he was treated in a sanatorium and given 1 g. streptomycin daily and 12 g. P.A.S. daily for ninety days.

INVESTIGATIONS.—In December, 1950, the urine was free from pus and tubercle bacilli, but he had hourly frequency by day and passed urine three to four times at night. The intravenous pyelogram showed a normal right kidney and slight dilatation of the ureter (*Fig.* 398). Subsequently the frequency of micturition became steadily worse and intravenous pyelograms in 1952 showed early dilatation of the right kidney and ureter (*Fig.* 399). In 1953 the frequency was half-hourly by day and five to six times at night, and there was sometimes nocturnal incontinence. On examination, his general condition was good but the right kidney was palpable. The prostate and seminal vesicles were normal. The urine contained neither pus nor tubercle bacilli and the blood-urea nitrogen was 19·1 mg. per cent. An intravenous pyelogram showed a hydronephrosis of the right kidney with an associated hydro-ureter, and the bladder was very small (*Fig.* 400). On cystoscopy, the bladder capacity was only 3 oz.; however, the mucosa was normal and smooth. The right ureteric orifice was normal, but in the region of the left ureteric orifice there were numerous septa between which were two saccules, the result of scarring of the bladder following the healing of deep tuberculous ulcers.

The problem was to enlarge the bladder and at the same time to relieve the hydronephrosis; this was satisfactorily solved by using an ileal loop as shown in *Fig.* 401.

FIG. 400.—Intravenous pyelogram, *Case* 7, May, 1953. This is an immediate pre-operative radiograph showing more advanced hydronephrosis and hydro-ureter.

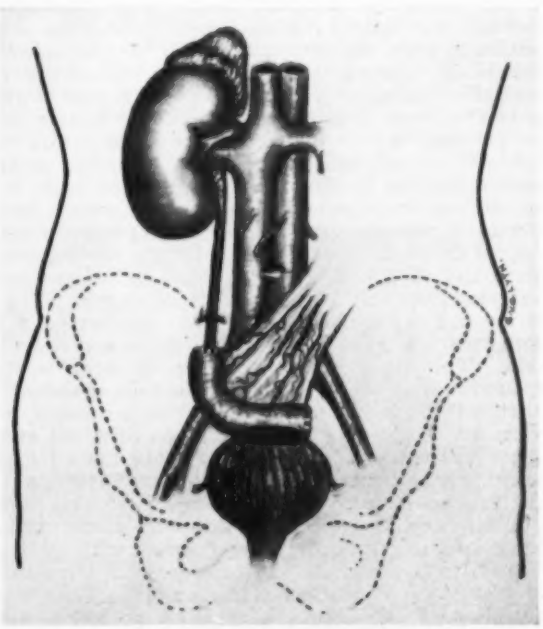
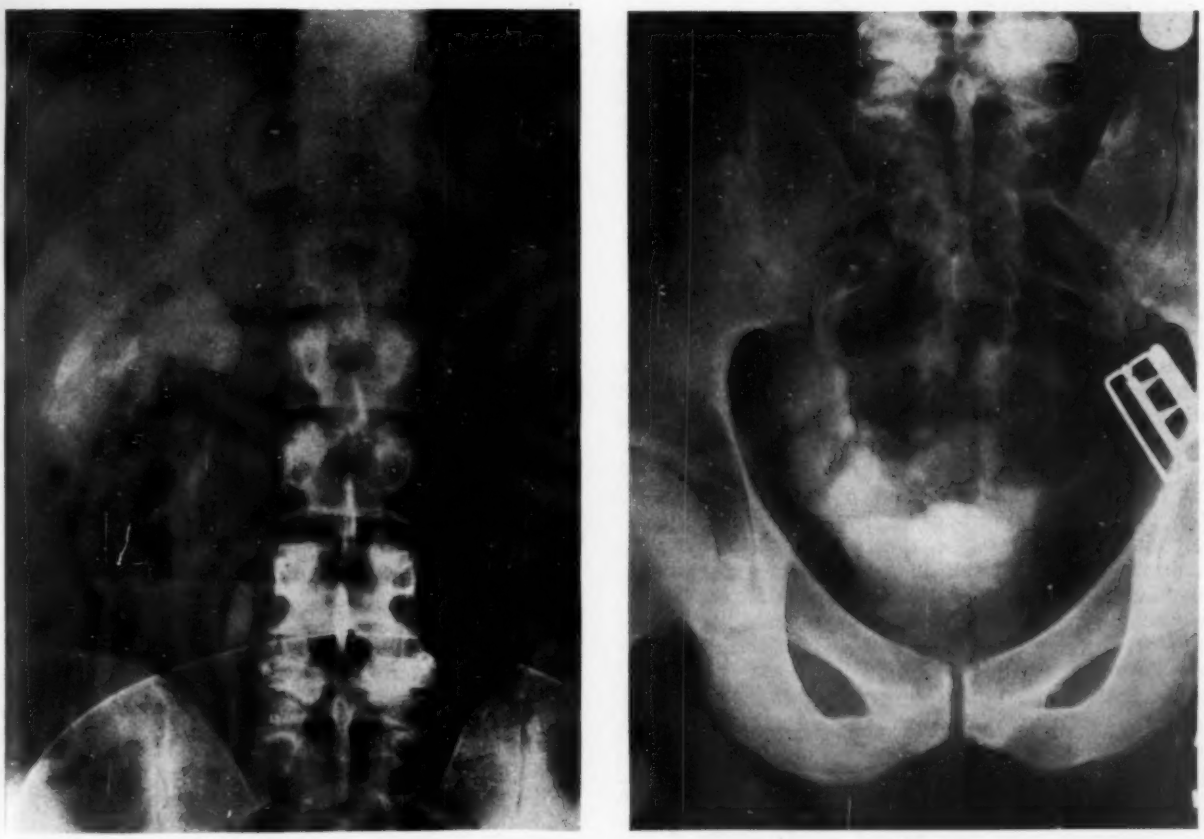


FIG. 401.—Diagram to show operation of uretero-ileocystoplasty (*Case* 7).



A B

FIG. 402.—A, Intravenous pyelogram six months after operation. B, Cystogram six months after operation showing filling of the ileal loop but no reflux up the ureter (*Case* 7).

AT OPERATION (L. N. P.).—On May 27, 1953, the abdomen was opened through a right paramedian incision extending from the symphysis pubis to 1 in. above the umbilicus. Examination of the bladder showed it to be contracted and slightly thickened in the region of the left ureteric orifice. The dilated ureter could be seen behind the peritoneum; its wall seemed to be of normal thickness and it vermiculated normally when the overlying peritoneum was stroked with a clip. The right kidney was normal on palpation. There was, therefore, nothing to suggest the presence of active tuberculous disease. A loop of the lower ileum, 9 in. in length, was prepared as previously described. The proximal end of the isolated coil was closed and infolded by catgut sutures. The side of the coil was anastomosed to the bladder by a wide opening some little distance from the closed end of the loop. The distal part of the loop of ileum was then secured to the peritoneum of the iliac fossa by interrupted stitches through its serosal coat. The peritoneum overlying the ureter was divided for some distance and the ureter was mobilized and divided below the level of the pelvic brim, the lower end being ligated. The upper end was implanted into the end of the ileal loop using a modified Coffey's technique, the end of the intestine being infolded around the ureter as shown in *Fig.* 401. A small piece of the ureter which was cut away showed no microscopical evidence of tuberculosis. The abdomen was closed with extraperitoneal drainage and a catheter was placed in the urethra.

POST-OPERATIVE COURSE.—From the fifth to the ninth day there was some discomfort and tenderness in the right iliac fossa and a slight elevation of temperature. From the ninth day onwards this rapidly subsided. There was no wound infection and no urinary leak. The urethral catheter was removed on the tenth day and convalescence thereafter was normal.

LATE RESULTS.—Micturition was reduced to normal frequency by day and nil to once at night. An intravenous pyelogram six months after operation showed a normal kidney, the hydronephrosis having subsided (*Fig.* 402 A); a cystogram showed adequate filling of the ileal loop, but no regurgitation up the ureter (*Fig.* 402 B). The urine is sterile but contains flakes of mucus.

DISCUSSION

This patient had intolerable frequency of micturition, the result of healed tuberculosis of the urinary tract producing a contracted bladder. Hydronephrosis of the remaining kidney was increasing. The orthodox treatment for such a patient is to transplant the ureters into the colon to relieve the frequency and in the hope that the hydronephrosis will either be reduced or not deteriorate. It seemed reasonable to try by a single operation to increase the capacity of the bladder and at the same time relieve the hydronephrosis. The success of this operation, like two of those described by Couvelaire (1950), introduces what may be a very valuable alternative treatment for this type of condition, for the transplantation of the ureter of a solitary damaged kidney to the colon risks further renal damage by infection or obstruction. It is believed that the margin of safety in transplanting one hydronephrotic kidney into the colon is less than when a bilateral transplantation is done for a patient with two reasonably healthy kidneys.

4. ILEUM USED TO REPLACE URETER

There are very few lesions of the wall of the ureter which do not merit nephro-ureterectomy. But some injuries or strictures may well be treated by excision of the whole or part of the ureter and replacement by ileum. Certain ureteric tumours may be treated similarly, as in the three patients reported below.

General Considerations.—It would be unwise to excise a portion from the centre of a ureter and interpose a short segment of ileum, for the outlet from the bowel to the distal ureter would be narrow and might well be a cause of obstruction. It therefore seems best to excise the whole of the ureter from the point of the disease down to and including the ureteric orifice and to replace it with a sufficiently long loop of ileum.

The three patients reported below all had ureteric tumours and these merit further discussion. These tumours were judged to be primary ureteric tumours because repeated careful pyelography had failed to show any other filling defects higher in the urinary tract. Also the size of the tumours and their round appearance suggested that they had been present for some considerable time, and had they been seedling tumours from a primary in the renal pelvis, such a primary could reasonably be expected to be sufficiently large to show on pyelography. However, it is not to be forgotten that if these tumours are primary ureteric tumours, they may well have small seedling tumours in the ureter below them or in the bladder. If such a tumour is to be treated by ureterectomy, it is therefore important to excise the ureter from the site of the primary tumour down to and including the ureteric orifice.

The Incision.—The above considerations determine the length and position of the abdominal incision, for it must be possible to reach the ureteric orifice and also the highest point of disease in the ureter. Moreover, since the anastomosis between the ureter and the ileal loop, and that between the ileal loop and the bladder, will have to be done at each extremity of the wound, it is important to make a long incision which will allow these anastomoses to be carried out with comfort and accuracy.

Excision of the Ureter and Position of the Ileal Loop.—There will be no difficulty in exposing the lower half of the ureter. It may be desirable, in securing the ureteric orifice, to open the bladder in order to make certain and sure dissection of this part by a combined intra- and extravesical approach. This part of the bladder can then be closed, leaving the principal incision into the bladder to be used for the anastomosis with the lower end of the ileal loop. The ileal loop can be placed inside or outside the peritoneum at the discretion of the surgeon.

If the upper part of the ureter also requires excision, either the right or left half of the colon will have to be mobilized and it will then have to be decided whether the upper end of the ileal ureter is to be placed behind or in front of the peritoneum. It may well cause less risk to the blood-supply of the upper end of the loop if it is kept intraperitoneal and is joined to the stump of the ureter through a separate incision carefully placed in the mesocolon. There seems to be no necessity in such cases to place the ileal loop deliberately behind the peritoneum; it should, however, be fixed in some way to the posterior parietal peritoneum in order to minimize the risk of torsion of its mesentery.

When the ileum is used to replace the right ureter it is convenient to implant the stump of the ureter into the distal end of the loop and to anastomose the proximal end of the bladder. The fact that this introduces an antiperistaltic segment into the urinary tract has not interfered with drainage and it does allow the mesentery to the loop to lie flat on the posterior abdominal wall.

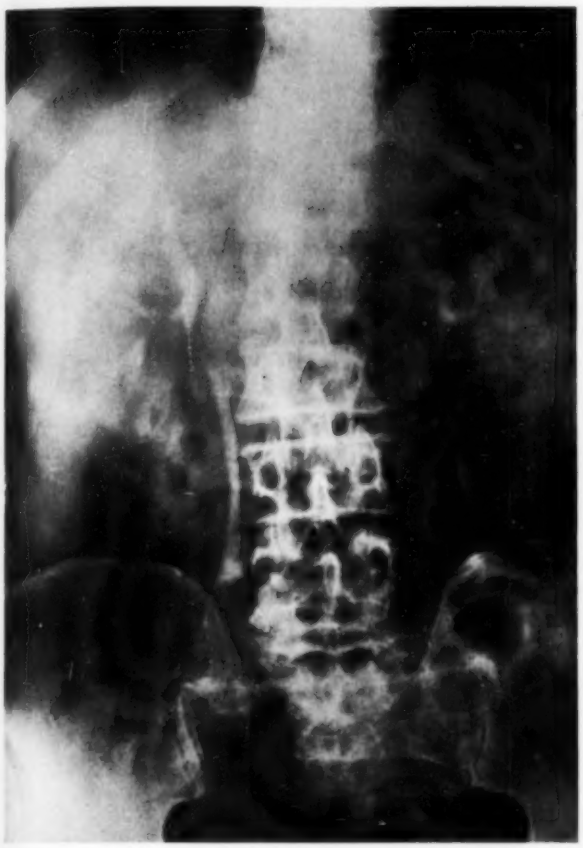


FIG. 403.—Intravenous pyelogram showing filling defect in the lower half of the right ureter (*Case* 8). Simple papilloma of the right ureter.

FIG. 404.—Papilloma of the ureter (*Case* 8). Photograph of the papilloma, which was histologically benign.

Case 8.—H. K., male, aged 52.

HISTORY.—He had painless hæmaturia for eighteen months, an investigation of which elsewhere by cystoscopy and intravenous pyelogram had failed to discover any cause. In August, 1952, he was first admitted to the Urological Unit with a further attack of hæmaturia accompanied by right renal colic.

INVESTIGATION.—Cystoscopy revealed blood coming from the right ureteric orifice. Intravenous pyelograms showed a normal left kidney but slight dilatation of the pelvis of the right kidney and a fusiform dilatation of the middle third of the right ureter, in the centre of which was a filling defect (*Fig.* 403). These findings were confirmed by an ascending pyelogram. The filling defect was thought to result from a papilloma; as no other filling defect could be seen higher in the urinary tract, it was decided to excise the lower two-thirds of the ureter and replace it with an ileal loop.

AT OPERATION (F. P. R.).—On Sept. 2, 1952, the right ureter was explored through a right paramedian incision and exposure of the palpable tumour through a small incision into the ureter showed that it was a pedunculated papilloma (*Fig.* 404). The ureter from 3 cm. above the tumour down to and including the ureteric orifice was excised. The bladder was opened to facilitate excision of the ureteric orifice. The ureter was replaced by an antiperistaltic loop of ileum 8 in. long. The ureter was implanted into the open upper end of the loop, its lower end being anastomosed in two layers to the opening previously made in the bladder. The antimesenteric border of the new ureter was fixed to the posterior abdominal wall by several interrupted sutures placed along the peritoneal margin of the bed of the original ureter. The ileovesical anastomosis was intraperitoneal.

The post-operative course was uneventful; there was no urinary leak. Histological examination of the specimen showed it to be a benign papilloma; no other tumours could be found in the part of the ureter removed.

SUBSEQUENT COURSE.—Intravenous pyelograms five months after operation showed slight diminution in the right hydronephrosis; both kidneys functioned normally.

Cystoscopy four months after operation showed no sign of bladder papilloma and the ileal mucosa had found a perfect union with the bladder mucosa. Contractions could be seen in the ileum and flocculent urine could be seen entering the bladder.

Six months after his operation the patient began to get attacks of colicky pain in the right iliac fossa which was referred to the epigastrium. He had some difficulty in micturition and attributed this to passing lumpy mucus down the urethra. He thought that his abdominal pain was made worse during micturition and especially when he had dysuria. These pains became worse, and examination during an attack showed some distended coils of bowel in the lower abdomen. On cystoscopy there was

no excessive mucus in the bladder and the ileal ureter was washed out with a polythene tube but very little mucus came from it. A cystogram showed the bladder and ileal ureter to be completely filled, but there was no reflux of dye into the remaining upper part of the right ureter.

SECOND OPERATION.—Laparotomy was carried out in October, 1953. He was found to have a firm adhesion between the lower ileum close to the ileocæcal valve and the scar on the anterior abdominal wall; this seemed to be causing intestinal obstruction and the adhesion was divided. The ileal ureter at operation seemed much smaller in calibre than normal ileum, and it had become completely fused with the peritoneum of the posterior abdominal wall of the pelvis. This operation completely relieved his abdominal pain despite the fact that he still continued to pass mucus in his urine and had occasional dysuria.

FIG. 405.—Intravenous pyelogram (*Case* 9). There is a left-sided hydronephrosis.

The patient remained well until July, 1954, when he again complained of similar abdominal pains and increased difficulty in micturition, which he again attributed to mucus. This is still under investigation, but certainly there is no obstruction of the ileal ureter by mucus. He has some prostatic enlargement and it may be that the addition of lumps of mucus to the urine increases his difficulty and produces painful distension of the ileal ureter.

Case 9.—T. C., male, aged 52.

HISTORY.—The patient had three attacks of hæmaturia in October, 1952, associated with left-sided renal pain usually of an aching character. There was further bleeding in December, 1952. There was no difficulty in micturition and no frequency.

INVESTIGATIONS.—Physical examination revealed tenderness along the lower part of the left ureter; neither kidney was palpable. The urine contained no pus and no organisms and was sterile on culture. The blood-urea nitrogen was 27·5 mg. Radiographs showed normal renal outlines and that both kidneys were secreting normally. The pelvis and caliceal pattern of the right kidney was normal, but the left kidney showed a moderate enlargement of the renal pelvis and a moderate degree of caliceal dilatation. The lower half of the left ureter was dilated above a well-marked filling defect believed to be due to an obstruction a few centimetres from the bladder (*Figs.* 405, 406). The shadow of the bladder was normal. On cystoscopy blood was seen coming from the left ureteric orifice. A catheter passed along the left ureter was partially obstructed 2·5 cm. from the bladder, but it was possible to manœuvre it past the obstruction; an ascending pyelogram confirmed the existence of a hydronephrosis and hydro-ureter.

FIG. 406.—Intravenous ureterogram showing filling defect of the lower third of the left ureter due to carcinoma (*Case* 9).

AT OPERATION (L. N. P.).—On Feb. 2, 1953, the left ureter was exposed extraperitoneally through a left lower paramedian incision and a firm tumour 5 cm. long was found in the wall of the ureter extending to within 2·5 cm. of the bladder. It had not penetrated the wall of the ureter, which was therefore easily mobilized. Five inches of ureter were excised, including the tumour and the ureteric orifice. The peritoneum was opened and a 6-in. ileal loop was prepared, the lower point of division being about 6 in. above the ileocæcal valve, to allow adequate displacement of the loop to the left. The ileal loop was then passed through a second opening in the lateral part of the pelvic peritoneum, thus bringing it to the position previously occupied by the excised ureter. The divided ureter was implanted into the upper end of the loop and the lower end was anastomosed to the bladder outside the peritoneum. The edges of the lateral incision in the peritoneum were then sutured to the back and front of the ileal loop to prevent herniation of the abdominal contents (*Figs.* 407, 408).

Convalescence was uninterrupted. The histological examination of the tumour showed that it was a poorly

differentiated transitional-cell carcinoma infiltrating the whole thickness of the ureteric wall.

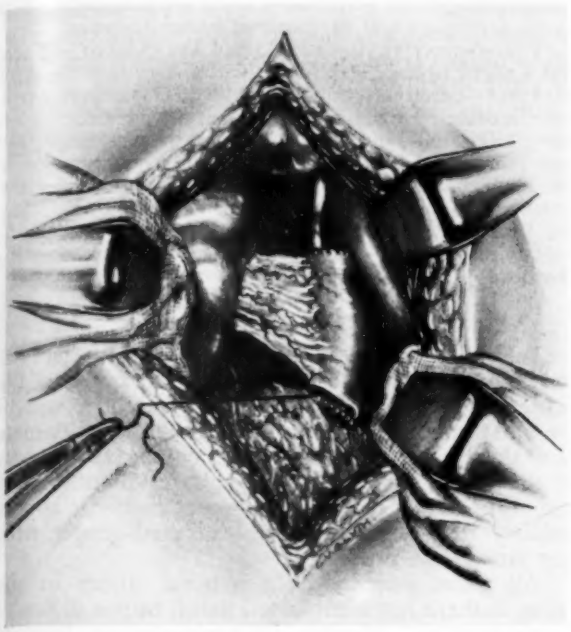


FIG. 407.—Operation of replacement of the lower third of the ureter with a loop of ileum (*Case* 9.) The loop has been drawn through an opening in the lateral part of the peritoneum.

Late Results.—Post-operative pyelograms showed a reduction of the hydronephrosis (*Fig.* 409). The cystoscopic appearance of the ileovesical junction was satisfactory.

FIG. 409.—Post-operative intravenous pyelogram (*Case* 9) showing a reduction in the hydronephrosis.

There was a well-healed linear scar and the mucosa at the anastomosis was of normal colour (*Fig.* 410).

Nine months after the operation he had hæmaturia, and on cystoscopy was found to have a recurrent papilloma 1 in. to the inner side of the old left ureteric orifice ; this was destroyed by diathermy. Fifteen months after operation

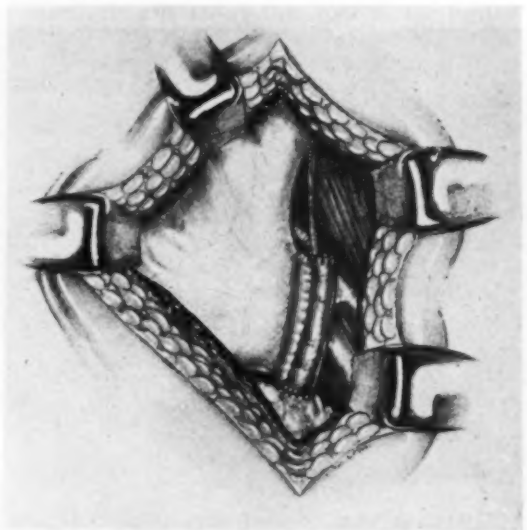


FIG. 408.—Replacement of the lower third of the ureter with a loop of ileum. The anastomosis has been completed and the peritoneum sewn to the wall of the ileum (*Case* 9).

he developed severe nerve-root pains believed to be due to metastases in the posterior part of the abdomen. From then on his condition deteriorated, and he died eighteen months after operation.

Case 10.—G. C., male, aged 50.

HISTORY AND INVESTIGATIONS.—The patient had painless hæmaturia since January, 1949, and previous

FIG. 410.—Cystoscopic view of the anastomosis between the ileum and the bladder (*Case* 9), six months after operation.

investigations had shown slight dilatation at the junction of the lower and middle thirds of the left ureter. On cystoscopy the bladder was normal. He had further hæmaturia in October, 1951, but no further examination

was made. In April, 1953, he was admitted to the Urological Unit with left renal colic but no hæmaturia.

No abnormality was found on clinical examination except for an abdominal scar made for a partial gastrectomy in 1949. A further intravenous pyelogram showed irregularity of filling in the lower third of the left ureter, and on cystoscopy there was a small papilloma ½ cm.

FIG. 411.—Cystogram in *Case* 9, two months after operation. This shows that the ileal loop is patent, but there is no reflux up the ureter.

above and medial to the left ureteric orifice. This was treated by diathermy. A bilateral ascending pyelogram confirmed the irregularity in the left ureter but showed that both the renal pelvis and the remaining parts of the ureter were healthy.

OPERATION (F. P. R.).—On May 5, 1953, with the patient tilted slightly on to his right side, an extraperitoneal exposure of the left ureter was made through a long oblique abdominal incision running from the tip of the twelfth left rib to the symphysis pubis. There was a palpable soft tumour in the ureter with no signs to suggest penetration of the muscle. The lower half of the ureter was therefore excised, including the ureteric orifice. The oblique incision gave good access to the lowest part of the ureter, and the orifice was excised by dissecting along the intramural part of the ureter until bladder mucosa was reached. This bladder incision was then closed. The peritoneum was then opened in a line rather more lateral than the incision through the abdominal wall and a loop of ileum prepared with its lower end about 10 in. above the ileocæcal valve. The stump of the ureter was pulled into the open upper end of the loop and the ileum closed carefully round it. The lower end of the loop was anastomosed to the left side of the bladder outside the peritoneum. The peritoneum was then closed by stitching it to the sides of the ileal loop so that the loop itself came to form part of the peritoneal lining of the pelvis, except for its upper and lower extremities, each of which were entirely extraperitoneal. He had urethral catheter drainage for five days and a small drainage-tube through the upper part of the wound for two days.

Histological examination confirmed that the papilloma was benign; there were many small seedling papillomata in the lowest inch of the piece of ureter removed.

POST-OPERATIVE COURSE AND LATE RESULT.—There was a slight urinary leak from the drainage-tube for three days post-operatively, but apart from this his convalescence was smooth. He has been seen regularly since and is quite free from symptoms. Cystoscopy six months and one year after operation has shown no recurrence of his bladder tumour. He has not had a post-operative intravenous pyelogram, but during the cystoscopies the ileal ureter has been seen contracting and urine containing flakes of mucus has been seen entering the bladder.

DISCUSSION

In the 3 cases reported the ileal ureter has functioned well and has allowed preservation of the kidneys. Whether it has been the correct treatment for what appear to be primary ureteric papillomata time alone will tell. One patient having a carcinoma of the ureter survived only eighteen months after operation. The pathological report makes it appear unlikely that he would have survived longer with any alternative procedure.

All three patients have noticed mucus in the urine, and one has complained that it causes difficulty in micturition. He has an antiperistaltic loop of ileum replacing his right ureter, but on cystoscopy the ileum can be seen contracting rhythmically and ejecting mucus-laden urine into the bladder. A few drops of indigo-carmine injected through a ureteric catheter into the upper part of the ileal loop appeared in the bladder in 55 seconds.

Since the junction between ileum and bladder is devoid of any valvular action, reflux of urine into the loop is bound to occur when the bladder contracts. This has already been described in the patients who have had an ileovesicoplasty. When a ureter has been implanted into the other end of the loop, the question of the reflux causing renal damage must be considered. In the two patients who have had cystograms after operation, although dye has filled the ileal loops, none of the dye has in fact entered the ureters (*Fig.* 411). This may be due to a valvular type of connexion between the ureter and the loop. A further possibility is that the ileal loop is easily distensible, and this may therefore absorb the increase of pressure occurring when the bladder contracts.

5. ILEUM USED AS AN ARTIFICIAL BLADDER

Indications.—These must depend upon the personal view of the individual surgeon. Although it has been termed an artificial bladder, the ileal loop here serves merely as a collecting tube for urine, emerging from the abdominal wall to which some form of bag can conveniently be attached. It is much easier to manage than bilateral cutaneous ureterostomies. It has been used extensively by Bricker (1950) as a means of collecting the urine after a total pelvic evisceration, and Wells (1953) favours this procedure following cystectomy rather than ureterocolic anastomosis. The two broad indications for its use in this series have been for patients

in whom ureterocolic anastomosis was required but could not be done, either because of a paralysed anal sphincter, rendering control of fluid fæces impossible, or because of severely damaged kidneys, when the added risk of ascending infection from the colon and the inability of such kidneys to compensate for the increased absorption of chlorides from the colon would have made ureterocolic anastomosis hazardous. In the first group are patients with urinary and fæcal incontinence due to spina bifida; in the second group are patients with long-standing ectopia vesicæ with renal damage. The procedure has not been used following cystectomy if the ureters can be anastomosed to the colon with reasonable safety, since the modern control of infection and control of the chemical imbalance is now better understood than three or four years ago.

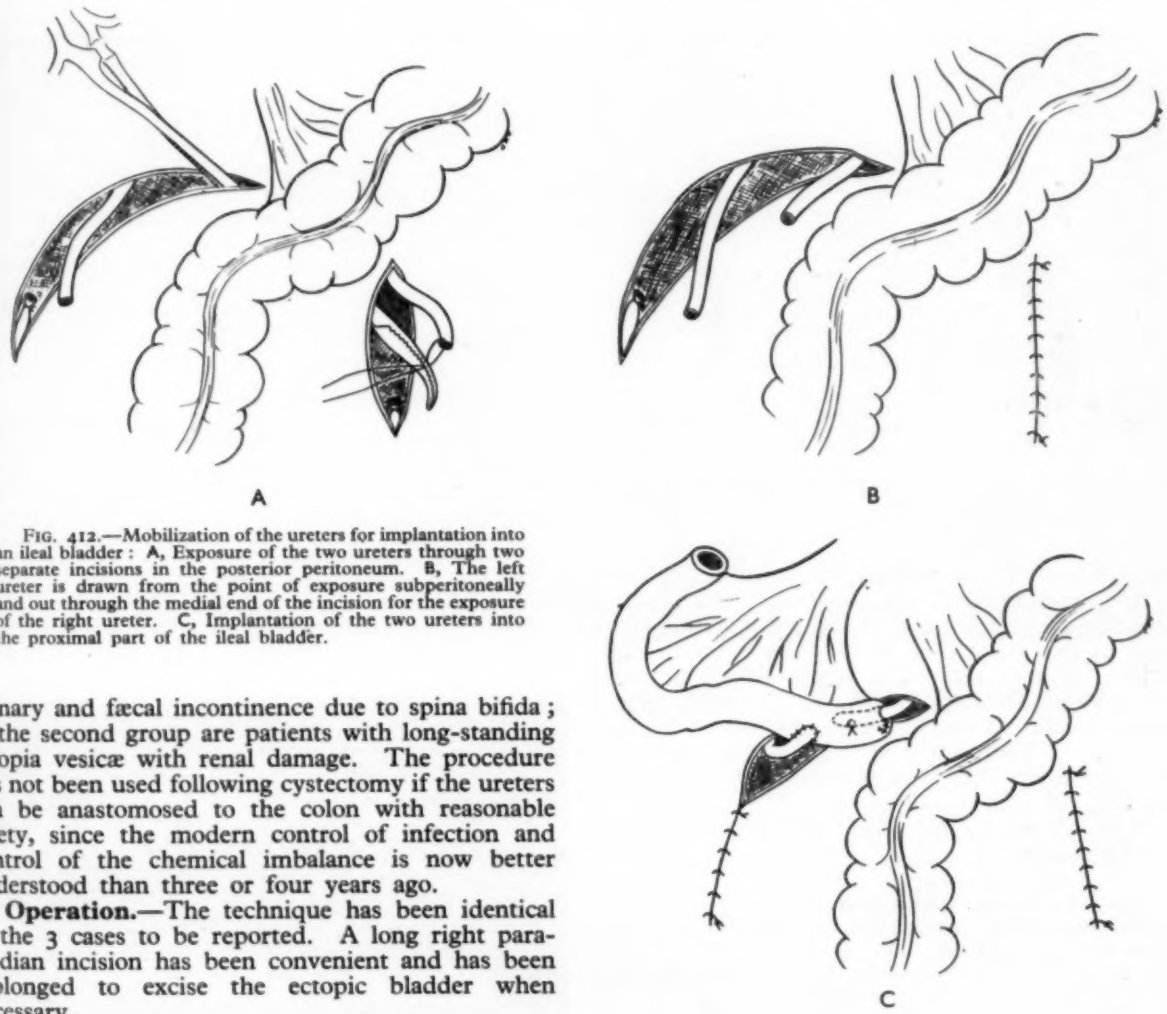


FIG. 412.—Mobilization of the ureters for implantation into an ileal bladder: A, Exposure of the two ureters through two separate incisions in the posterior peritoneum. B, The left ureter is drawn from the point of exposure subperitoneally and out through the medial end of the incision for the exposure of the right ureter. C, Implantation of the two ureters into the proximal part of the ileal bladder.

Operation.—The technique has been identical in the 3 cases to be reported. A long right paramedian incision has been convenient and has been prolonged to excise the ectopic bladder when necessary.

Exposure of Ureters.—The right ureter is mobilized through a transverse incision through the posterior peritoneum over the sacral promontory and curved at the right end along the line of the right ureter. The degree of mobilization of the right ureter depends upon whether the lower part is to be removed, as for instance when an ectopic bladder is excised (*Fig.* 412).

The left ureter is then exposed through another incision on the lateral wall of the pelvis and is freed up to and behind the sigmoid colon. Two methods have been used in the further mobilization of the left ureter, and they are shown diagrammatically in *Figs.* 412. If the sigmoid mesentery has been long and the vessels in it have been easily detected, a cholecystectomy forceps has been passed behind the sigmoid mesentery down to the opening in the peritoneum made for exposure of the left ureter (*Fig.* 412). The divided ureter has been then pulled out through the left-hand end of the peritoneal incision made across the sacral promontory, and implanted into the proximal end of the loop (*Fig.* 412). If there has seemed the slightest risk of injury to the vessels in the sigmoid mesentery the ileal loop has been brought across the front of the upper part of the rectum and the left ureter has been implanted into the open proximal end of the loop at the point where it had been exposed on the lateral pelvic wall (*Fig.* 413).

Preparation of the Ileal Loop.—A loop of ileum at least 30 cm. long is required and this is isolated as previously described. The left ureter is then pulled into and fixed in the upper end of the loop. The right ureter is anastomosed to the antimesenteric border of the loop about 5 cm. below the left ureter, the exact technique having varied. The quickest method is to make a very small hole in the ileum and to pull the ureter through it with a stitch on a long straight needle, the needle emerging through the ileum again about 3 cm. below the opening. On other occasions a Nesbit type of anastomosis has been made. These two anastomoses are then

covered by the peritoneum on the posterior abdominal wall. The ureteric anastomoses are made well towards the proximal end of the loop in order to leave sufficient loop to cross the posterior wall, to pass round the lateral wall of the right iliac fossa on to the anterior abdominal wall, and to emerge through a small separate incision in the abdominal wall lateral to the main incision. This second

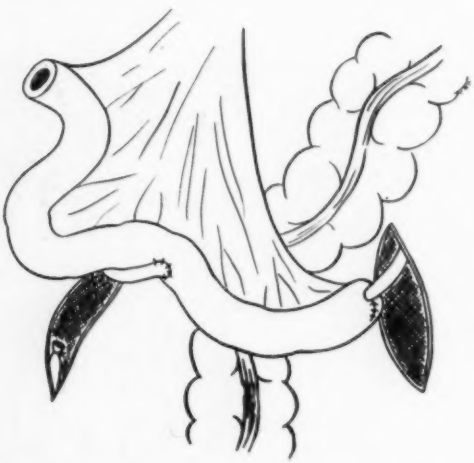


FIG. 413.—An alternative site for anastomosis of the left ureter to the ileal bladder, bringing the ileum in front of the rectosigmoid junction.

incision must be so placed that a Rutzen bag can be conveniently fitted over it. The ileal loop, as it passes across the walls of the right iliac fossa, is fixed to the peritoneum by a series of interrupted sutures. About 2·5 cm. of ileum should protrude through the abdominal wall and the extremity is turned inside out and the edge stitched to the skin incision. A Foley catheter is left in the loop until the main wound has healed, when a Rutzen type of bag is fitted over the ileostomy.

The following case reports illustrate the uses of this operation.

Case 11.—N. C., male, aged 42.

HISTORY.—The patient had an operation for spina bifida when he was two days old, but he was left with urinary and fæcal incontinence. He also had anæsthesia in the saddle area and hypo-æsthesia of the right leg and foot below the knee and of the sole of the left foot. As he grew older the fæcal incontinence became to some extent controlled but is still imperfect. At the age of 7 he was fitted with a rubber urinal and he used a succession of these until the age of 20. By that time the pressure from the urinal had produced a fistula at the penoscrotal junction. He then obtained a gum-elastic catheter and a wooden spigot and he passed the catheter into the urethra through the fistula and kept it permanently in place by bandaging it to the penis, removing the spigot when he wanted to pass water. At the age of 21 he had a stone removed from his bladder through a suprapubic incision. The urethral catheter gradually wore away the urethra and he controlled leakage for a time by increasing the circumference of the catheter by wrapping insulating tape round it (*Figs.* 414, 415, A). Finally, he had a large opening in the centre of the scrotum and could no longer keep the catheter in place and in this state he first attended the out-patient department.

EXAMINATION.—He was a fit man and apart from the neurological defects mentioned above the main interest lay in the urethra (*Fig.* 415, B). The penis was reduced to a fibrous remnant and there was a large hole at the base of the scrotum through which urine constantly trickled. A thumb could easily be passed through the opening into the bladder. The anal sphincter was very lax. The urine was slightly infected and an intravenous pyelogram showed that both kidneys were normal.

OPERATION (F. P. R.).—This was carried out on Sept. 10, 1953.

Construction of ileal bladder: It was impossible to transplant the ureters to the colon because of the incontinence and they were therefore transplanted to a loop of ileum, the lower end of which was brought out through the centre of the right paramedian incision. A Foley catheter was used to collect the urine until the wound had healed and a Rutzen bag was then applied and has been used ever since (*Fig.* 415, C). His post-operative progress was completely uneventful.

SUBSEQUENT COURSE.—He has been able to keep absolutely dry and has been at full-time work as an electrician. He changes the bag either daily or every two days and the skin round the ileostomy has not become sore. He has no chemical imbalance and is on a normal diet, but has noticed an increased thirst during the last three months.

Case 12.—R. B., male, aged 58.

HISTORY.—The patient had an ectopia vesicæ. Four attempts had been made to close the anterior wall of the bladder in the first ten years of his life, but all had failed. In an attempt to keep himself dry, he wore large towels folded like a napkin. He never went to school, but learnt the trade of a shoe-repairer which he managed successfully until the age of 58, when he began to get headaches, dizziness, and dyspnœa. He had occasional pain in the right loin and at about the same time the ectopic bladder became extremely tender, so that he could hardly bear the pressure of the towel. For these

FIG. 414.—Gum-elastic catheter wrapped with insulation tape used by the patient as a spigot for a large urethral fistula (*Case* 11).

reasons he was admitted to hospital in June, 1952, where investigations suggested that his headaches and dizziness were due to hypertension (250/130). His heart was considerably enlarged. The urine collected from each ureter was heavily infected and the blood-urea nitrogen was 43 mg. per cent. An intravenous pyelogram showed no concentration of dye in the right kidney and some hydronephrosis of the left kidney. An ascending pyelogram showed a considerable degree of right hydronephrosis and hydro-ureter. The ectopic bladder was very red and extremely tender, but there was no obvious tumour present.

Despite his considerable hypertension, it seemed advisable to remove the ectopic bladder, but because of

the severe renal damage transplantation of the ureters to the colon would have been hazardous.

OPERATIONS.—

1. July 16, 1952 (F. P. R.).—The bladder was excised and the ureters were mobilized from the pelvic wall. An attempt was made to construct a bladder from the lower 6 in. of ileum, the cæcum, and about 2 in. of ascending colon, the ureters being anastomosed to the cæcum and the ileum being brought out through the upper part of the wound. A Foley catheter was left in

A B C

FIG. 415.—*Case* 11. A, The spigot is shown in position in the fistula in the urethra. B, This shows the large opening of the fistula and the atrophied penis. C, Rutzen bag in position over the stoma.

the ileum. Continuity of the alimentary tract was restored by anastomosing the end of the divided ileum to the transverse colon. The cæcum lay very low in the pelvis and required almost no mobilization to bring it to lie in the position of a normal bladder.

This operation was not successful. The catheter never drained satisfactorily and a urinary leak developed at the site of anastomosis of the right ureter to the cæcum and eventually all the urine drained through the lower part of the wound. One attempt was made to seal the leak but was only temporarily successful.

2. October 22, 1952 (F. P. R.).—After a period of convalescence, a second operation was done at which the cæcal bladder was excised and a new loop of lower ileum prepared. The left ureter was implanted into the proximal end of the loop and the right ureter anastomosed to the side of the loop by a direct mucosal anastomosis about 3 in. below the left ureter. The distal end of the loop was brought out through the abdominal wall 2 in. to the right of the midline and level with the highest point of the iliac crest.

Post-operatively he had paralytic ileus, but he eventually recovered. A Foley catheter was first used to drain urine from the ileum, but was later replaced by a Rutzen bag. Because of the two operations he was in hospital for almost six months, but when he left he was able to be kept dry for the first time in his life.

SUBSEQUENT COURSE.—After a period of convalescence he returned to work. There was never any reduction in his hypertension. He had no symptoms to suggest any chemical imbalance. He changed the bag every two days and used to empty it once during the night. Nine months after leaving hospital he was re-admitted, having been found unconscious in his shop. He died four hours after admission and a post-mortem showed that the cause of death was a very extensive right cerebral hæmorrhage. There was a right pyonephrosis, there being very little functioning renal tissue remaining. The left kidney looked normal, except for slight inflammation of the renal pelvis. The only other feature was an enormous heart weighing 1000 g., the increase in size being mainly due to hypertrophy of the left ventricle. *Fig.* 416 shows the state of the kidneys, ureters, and part of the ileal loop. Both ureters were smaller than at the time of the operation. The ureteric openings both look like small papillæ despite the fact that the left was implanted by pulling it into the open end of the loop and the right was anastomosed by direct mucosa-to-mucosa suture. A probe could quite easily be passed through both openings.

Case 13.—F. A., male, aged 30.

HISTORY.—The patient had an ectopia vesicæ over which he had worn towels and rubber pants for the whole of his life. He worked as a farm labourer and came to hospital because of pain in the region of the bladder and an attack of left-sided pyelonephritis.

INVESTIGATIONS.—His blood-urea nitrogen was 18 mg. per cent and radiographs of the renal tract showed that both kidneys functioned satisfactorily and there was no hydronephrosis. The bladder itself was very red and in places was covered with small cysts. Infected urine was obtained from both ureters.

It was decided to excise the bladder and anastomose the ureters to a loop of ileum using a Rutzen bag to collect the urine from the ileostomy.

AT OPERATION (F. P. R.).—The operation was done without any difficulty on Sept. 30, 1953. A 14-in. loop of lower ileum was used as the artificial bladder, the left ureter being implanted into its upper end and the right ureter anastomosed to the side of the ileum.

SUBSEQUENT PROGRESS.—His progress was satisfactory for seven days and urine drained well into the Rutzen bag. On the eighth day he developed some abdominal distension and on the ninth day he vomited and the urine output was diminished. The abdomen was quite silent and he was thought to have developed paralytic ileus. The fluid balance was maintained by intravenous infusions but his blood-urea began to rise. On the tenth day some blood-stained fluid drained from the ileostomy and the protruding ileum became cyanotic. During the next twenty-four hours further blood-stained fluid came from the ileal loop and the protruding ileum became plum-coloured. He collapsed and died within an hour on the twelfth day. At that time the blood-urea nitrogen was 140 mg. per cent, the chloride 410 mg. per cent as NaCl and the CO_2-combining power 36 vol. per cent.

A post-mortem showed that the ileal loop had become almost gangrenous; no obvious cause was found for this. The pedicle had not twisted. The rest of the ileum was distended but the anastomosis was satisfactory and was patent. The ureters were not obstructed and the upper urinary tract was free from infection. Histological examination of the bladder showed no evidence of carcinomatous change, but most of the surface epithelium was of stratified squamous type.

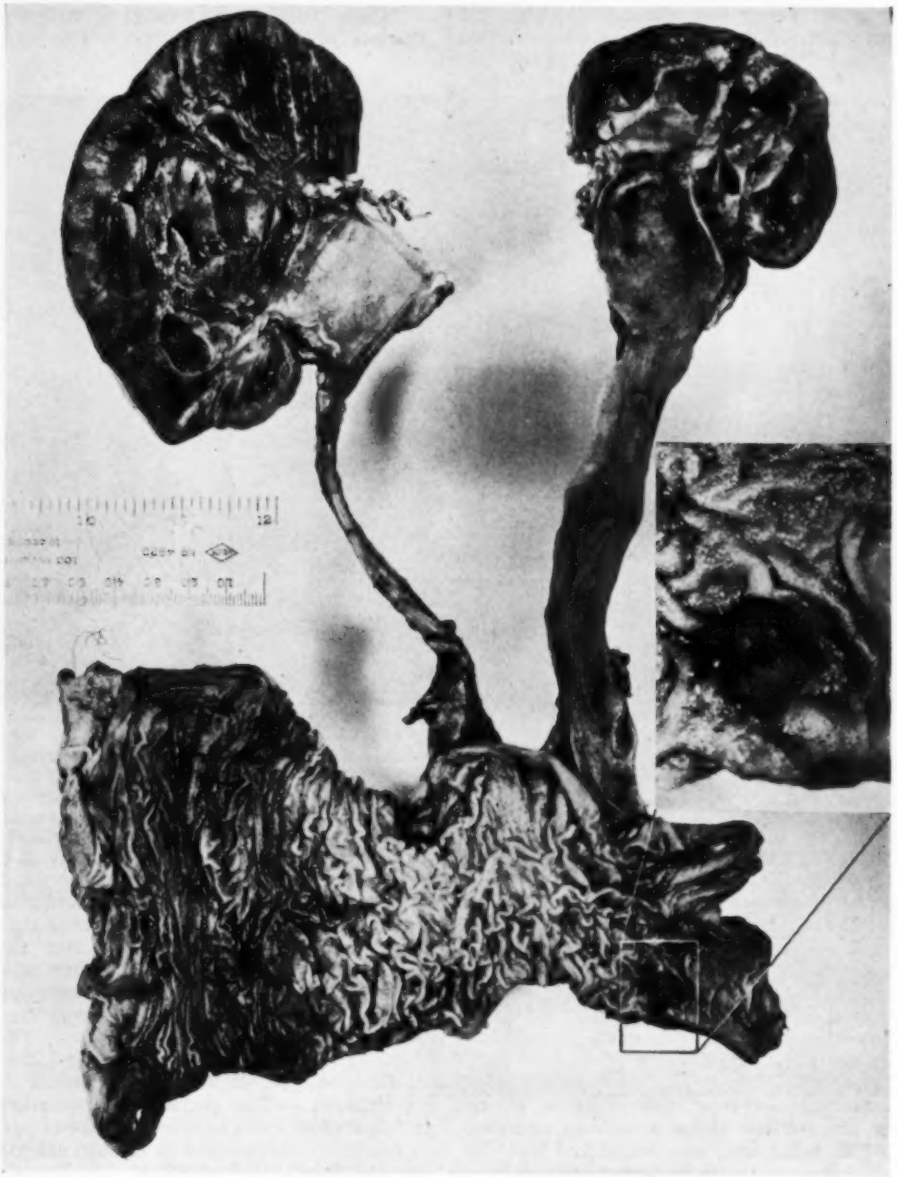


FIG. 416.—Autopsy specimen, *Case* 12. For description see text.

DISCUSSION

The creation of an ileal bladder with or without a cystectomy is a major operation, but it does give a satisfactory result in that the patient is comfortable and socially acceptable. The Rutzen bag is not difficult to manage and the type with a detachable bag recently developed by Wells (1954) may prove to be an added simplification.

If it is an operation to be recommended for the patient with urinary and rectal incontinence due to

a spina bifida, some decision will have to be made about the age at which it is to be performed. Some of these patients die when quite young from hydrocephalus or urinary tract infections. Those who survive sometimes develop a moderate control of bowel function during their teens, and it may be best to wait for this to occur before constructing an ileal bladder. It is not possible to lay down any hard-and-fast rule, but each case must be judged carefully, taking into account the general prognosis, family background, and possible psychological disturbances.

SUMMARY

1. The lower ileum is suitable anatomically and physiologically for incorporation in the urinary tract. Possible biochemical changes following such operations have been discussed.

2. Relatively few reports of operations of this type have been found in the literature, which is reviewed in detail.

3. A series of 13 cases is reported in which an isolated coil of lower ileum is used to enlarge a contracted bladder, to relieve at the same time a contracted bladder and a hydronephrosis of a solitary kidney, to re-anastomose ureters previously transplanted into the colon to the bladder, to replace part of a ureter excised for neoplasm, and to act as an artificial bladder.

4. The results of these operations are discussed.

We desire to thank Mr. J. Hainsworth for the photographs, Mr. C. V. G. Lyth for the drawings and paintings in *Figs.* 393, 396, 397, 401, 407, 408, and 410, and Miss C. E. Campbell for the drawings in *Figs.* 389, 390, 391, 412, and 413.

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THE MIGRATION OF SODIUM, CHLORIDE, AND POTASSIUM IONS ACROSS THE MUCOUS MEMBRANE OF THE ILEUM

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INTRODUCTION

AN isolated loop of lower ileum has been used for various urological procedures, intestinal continuity having been restored by lateral anastomosis. A series of cases has been reported in this issue by Pyrah and Raper (p. 337) in which a coil of ileum was used to enlarge a contracted bladder, to replace an excised portion of ureter, to relieve simultaneously a contracted bladder and an associated hydronephrosis of a solitary kidney, to re-implant previously transplanted ureters into the bladder, and also to

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act as an artificial bladder. The clinical results of these operations have been satisfactory. In no case has any electrolyte imbalance been noted.

Following uretero-colic anastomosis, biochemical changes are known to occur and these include a differential absorption of sodium and chloride ions across the colonic mucosa; such absorption may result in a hyperchloræmic acidosis if the kidneys have been damaged by infection. These changes have been described in earlier papers from this clinic and views have been put forward concerning their mechanisms (Parsons, Powell, and Pyrah, 1952; Parsons, Pyrah, Powell, Reed, and Spiers, 1952; Pyrah, 1954). It is clearly desirable to determine if any such changes occur following the contact of urine with the mucosa of an ileal loop in the operations referred to above.

Investigations into the ionic migration occurring across the mucous membrane of the ileum are presented in two cases. The first is devoted to a study of the possibility of chemical imbalance arising after the operation of uretero-ileocystoplasty, whilst the second centres upon the use of a perfusable loop of terminal ileum designed to act as an artificial kidney.

Visscher, Fletcher, Carr, Gregor, Bushey, and Barker (1944) have shown by the use of radio-isotopes in dogs that there is a greater absorption of sodium from perfused loops of small intestine the more distal the intestinal segment, while the secretion of sodium is diminished. They succeeded in calculating the absolute rates of movement of sodium and chloride ions and also of water in both directions across the intestinal wall and concluded that there is a forced flow of liquid across the intestinal epithelium in both directions simultaneously. Differences in the solute content of the water in the two streams and the relative rates of the streams were thought to determine the direction and magnitude of net transport. The apparent concentrations of chloride and sodium ions in the fluid moving from gut to blood are greater than those in the ingoing perfusion fluid over a large range of gut fluid concentrations, so that a net absorption of sodium and chloride ions from the gut may be expected to occur. In this connexion, Bricker (1950) and Wilson (1953) have recorded instances of hyperchloræmic acidosis after implantation of the ureters into an ileal loop. Such cases, although unusual, may indicate a differential uptake of chloride ions relative to sodium ions according to the mechanism indicated by Parsons and his co-workers (1952) for absorption by the colon. Tasker (1953) has reported a case in which death from hyperkalæmia was suspected as a result of absorption of potassium after ileocystoplasty and subsequent failure in the mechanism of potassium elimination brought about by oliguria. He has shown in dogs that an absorption of potassium takes place from a bladder enlarged in this way.

Kolff (1947) has described the operation of an artificial kidney in the form of an isolated loop of terminal ileum. He used as a perfusion fluid a solution which was approximately isotonic with the plasma of the patient calculated on the basis of the plasma water and corrected for the Donnan Equilibrium effect brought about by the indiffusible, negatively charged protein molecules in the plasma. Perfusion with this fluid resulted in the removal of both urea and calcium from the patient but by a suitable adjustment of the calcium level in the fluid this loss of calcium by the body was prevented.

Twiss and Kolff (1951) later used an isolated loop of midgut and found that at this higher intestinal level the sodium and potassium blood and loop changes were similar to those of the terminal ileum. A perfusion fluid similar to that devised by Kolff was used at the fast flow rate of about 23 ml./min. by Thompson, Lewis, and Alving (1952) for the treatment of chronic uræmia. They verified Kolff's observation that the concentration of urea removed by the loop was greater the slower the rate of perfusion. A comparison is given between our results and those they obtained (*Table XI*).

1. CHEMICAL IMBALANCE AS A RESULT OF URETERO-ILEO-CYSTOPLASTY

CASE REPORT

This case is *Case* 6 in the paper by Pyrah and Raper in this journal (p. 345) where it is described in full. Briefly, the patient, a woman aged 42, had had bilateral uretero-sigmoidostomy following a large vesicovaginal fistula. Following the transplant she had several severe attacks of recurrent ascending renal infection with electrolyte imbalance which threatened to inflict permanent damage upon the kidneys. The fistula in the disused bladder, now much smaller, was repaired and the ureters were reconnected to the bladder using a loop of ileum, the middle of which was anastomosed to the bladder; the ureters were attached to the ends of the loop. Clinically the patient has been well and no further electrolyte imbalance has been noted.

Method of Investigation.—In view of the findings reported by Bricker (1950) and by Wilson (1953), interest was centred upon the possibility of a differential absorption of chloride relative to sodium ions. It was first necessary to determine if there was any differential migration of sodium and chloride ions across the mucosa of the excluded bladder, before determining the effect in this respect of the addition of a coil of ileum to the bladder. The difference between the results obtained in the two experiments may then be attributed to the presence of the loop of ileum.

Table I.—THE COMPOSITION OF THE ARTIFICIAL URINE

	Grammes/litre
Sodium	1·9
Chloride	2·8
Urea	13·4
Sulphuric acid	2·45
Ammonium bicarbonate	1·94
Potassium dihydrogen orthophosphate monohydrate	3·49
Creatinine	1·00
Hydrated magnesium sulphate	1·50
Calcium lactate	1·11

The investigation was first carried out when both ureters had been transplanted into the colon and the bladder fistula had been repaired. The technique was to introduce into the bladder 100 ml. of an artificial urine labelled with the radio-isotopes ^{24}Na and ^{38}Cl (half-lives 15 hours and 38 minutes respectively) and to observe the movement of these radio-isotopes into the blood. The chemical composition of the artificial urine is shown in *Table I*.

This fluid was retained in the bladder for 60 minutes and during this time blood samples were taken at suitable intervals. The activity of each sample and also that of a suitably diluted fraction of the original bladder solution was measured over a time scale in type M6 liquid counters: analysis of the decay curves, based on the difference in the half-lives of the two isotopes, gave the concentrations of ^{24}Na and ^{38}Cl appearing in the blood relative to their initial concentrations in the artificial urine introduced. (Allowance was made for the relative sensitivities to the two isotopes of all the Geiger counters used.)

In order to derive the relative migration rates of the two ions from the blood concentrations, it was necessary to make an allowance for the different volumes which sodium and chloride ions occupy in the body and for the different rates at which movement into these volumes takes place. This was done by an intravenous injection of sterile, buffered ^{24}Na and ^{38}Cl, followed by the measurement with time of the activities of blood samples taken at intervals up to an hour after this injection. The accurately measured volume of 5 ml. which was injected contained approximately 10 μC of ^{24}Na and not more than 70 μC of ^{38}Cl. By a comparison of the activities of the blood samples and of the injected solution, the dilution factors and hence the effective body spaces were derived over a time scale similar to that used in the ionic migration studies. Thus the true differential rate of migration into the blood of chloride and sodium ions across the membrane concerned could be determined.

This use of radio-isotopes not only gives a measure of the movement of sodium and chloride ions from the bladder into the blood but also, when combined with the chemical analysis of the artificial urine, before and after retention in the bladder, enables one to discriminate between the net movement and the flow in either direction occurring in dynamic interchange.

The same procedure was repeated when the patient had had one ureter anastomosed to an ileal loop, itself anastomosed to the bladder. In this case, 250 ml. of an artificial urine was used which contained 3·66 g. sodium chloride per litre in addition to the other constituents shown in *Table I*. This fluid was retained for 70 minutes. Any difference between the results obtained after 60 minutes and those obtained with the excluded bladder may then be attributed to the presence of the loop of ileum.

A complication arises when one ureter has been re-implanted into the bladder, from the addition of natural urine to the bladder during the investigation, but this may be resolved if the amount and composition of this urine is determined.

Results.—

a. The Excluded Bladder with Both Ureters Transplanted into the Colon.—The uptake by the blood of ^{24}Na and ^{38}Cl via the bladder wall is expressed as a function of time in *Fig.* 417. The concentration of each radio-isotope in the fluid introduced is expressed in terms of the average total concentration of that ion (in mEq./l.) in order to allow for the effect of isotopic dilution. The correction which has to be made for the difference in the effective body spaces of the two ions and in their rates of movement into these spaces is made in the following way.

By the method already outlined, curves were obtained for sodium and chloride which related their effective body spaces with time (*Fig.* 418). It was assumed that these curves are of the form $y_t = y_\infty - ce^{-\lambda t}$, where y_t is the effective body space at time t. By trial and comparison, values for the

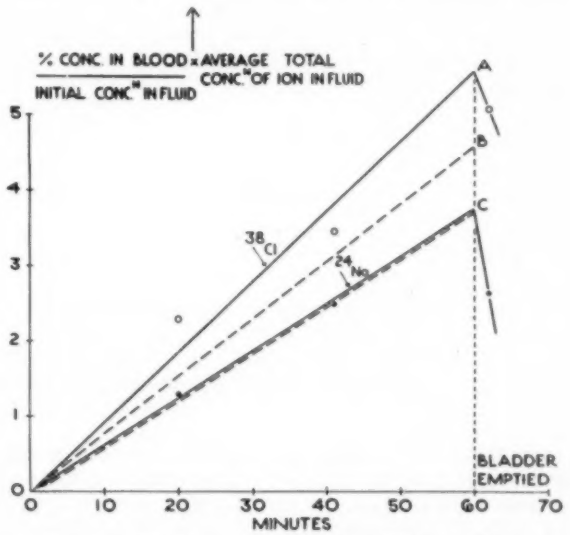

FIG. 417—The absorption of $^{24}Na^+$ and $^{38}Cl^-$ ions from an excluded bladder (the ureters having been transplanted into the colon) and the subsequent uptake of these ions by the blood. The ordinates are expressed in mEq./l. The continuous lines OC and OA represent the observed uptake by the blood of ^{24}Na and ^{38}Cl. The dotted lines OC and OB represent the absorption of $^{24}Na^+$ and $^{38}Cl^-$ ions calculated from the effective body spaces on the assumption that they are absorbed in equivalent amounts. AB represents the true differential uptake after 60 minutes of $^{38}Cl^-$ ions relative to $^{24}Na^+$.

constants y_∞, c, and λ were obtained from the curves for both ions. If next we consider the transmission of the ions contained in the bladder across the wall into the blood, we may suppose that the activity transmitted is proportional to time during the period of the investigation. If α is the number of μC transmitted in unit time, then, in an interval dt, $\alpha.dt\ \mu C$ enters a space y_t which increases with time as determined in the body space experiment. Thus the measured concentration is of the form:—

$$\int_0^t \frac{\alpha.dt}{y_t} = \int_0^t \frac{\alpha.dt}{y_\infty - ce^{-\lambda t}} = \frac{\alpha}{y_\infty}\int_0^t \left(1 - \frac{ce^{-\lambda t}}{y_\infty}\right)^{-1}.dt = \alpha.F_t$$

F_t can be evaluated for both the sodium and the chloride ions and a comparison of the calculated F_t curves with the observed concentration curves gives the relative values of the migration rates, α, for the two ions. In *Figs.* 417 and 419 the calculated curves (dotted) for sodium are fitted arbitrarily to the experimental curves at one point (t = 50 min.) and the dotted curves for chloride are those calculated on the basis of $\alpha_{Cl} = \alpha_{Na}$. Since the agreement with the experimental curves is reasonably close, this suggests that the migration rates for the Na^+ and Cl^- ions are in fact approximately equal in this case.

The analyses of the fluid used before and after retention in this excluded bladder are shown in

Table II. Except for urea, there is no appreciable net movement across the bladder wall of those ions studied. Thus, the migration of sodium and chloride ions across the bladder epithelium is a dynamic process in which movement in both directions takes place simultaneously.

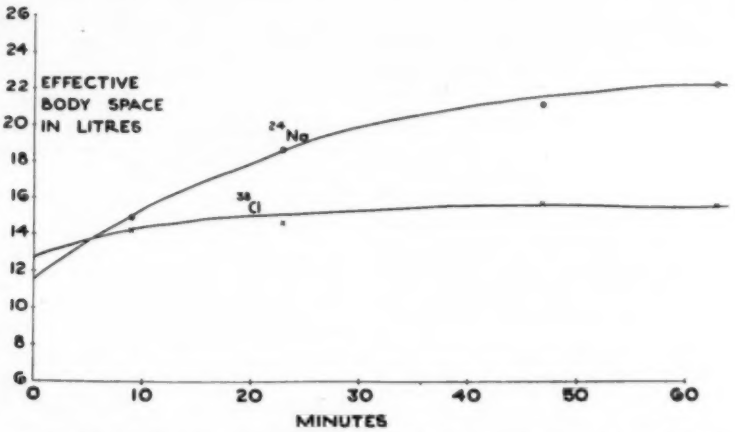

FIG. 418.—The relationship between the effective body spaces and the time after an intravenous injection of $^{24}Na^{+}$ and $^{36}Cl^{-}$ ions.

b. Bladder and Attached Ileal Loop.—The uptake by the blood of ^{24}Na and ^{38}Cl is shown as a function of time in *Fig.* 419. The effective body spaces of the sodium and chloride ions were determined by

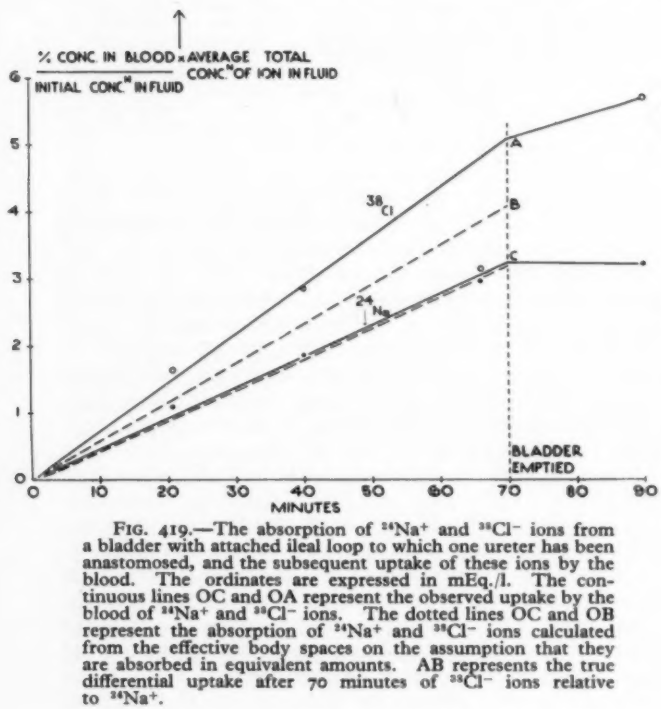

FIG. 419.—The absorption of $^{24}Na^{+}$ and $^{36}Cl^{-}$ ions from a bladder with attached ileal loop to which one ureter has been anastomosed, and the subsequent uptake of these ions by the blood. The ordinates are expressed in mEq./l. The continuous lines OC and OA represent the observed uptake by the blood of $^{24}Na^{+}$ and $^{36}Cl^{-}$ ions. The dotted lines OC and OB represent the absorption of $^{24}Na^{+}$ and $^{36}Cl^{-}$ ions calculated from the effective body spaces on the assumption that they are absorbed in equivalent amounts. AB represents the true differential uptake after 70 minutes of $^{36}Cl^{-}$ ions relative to $^{24}Na^{+}$.

the method outlined above and the resultant calculated curves are also shown. The calculated sodium curve (dotted) is fitted to the experimental curve at $t = 50$ min. The corresponding chloride curve, based on the arbitrary assumption that $\alpha_{Cl} = \alpha_{Na}$, is shown dotted.

Table III gives the results of the analyses of the fluid before and after its retention in the bladder.

Since the interpretation of these analyses is complicated by the gradual addition of urine via the replaced ureter during the experiment, a specimen of urine was collected at the commencement of the experiment. It was inadvertently lost, however, so that no accurate estimation of the direction and

Table II.—THE COMPOSITION OF AN ARTIFICIAL URINE BEFORE AND AFTER RETENTION IN A BLADDER ISOLATED FROM THE KIDNEYS

		BEFORE RETENTION	AFTER RETENTION
Time	min.	0	60
Volume	ml.	100	93
Cl	mEq.	7·86	7·52
Na	mEq.	8·40	8·07
K	mEq.	2·55	2·44
Urea	mg.	820	642

magnitude of the net movement of the ions concerned could be attempted.

However, from a comparison of the curves shown in *Figs.* 417 and 419, it appears that :—

i. The addition of the ileal loop to the bladder makes no significant difference to the transmission of sodium and chloride ions from bladder to blood.

Table III.—THE COMPOSITION OF AN ARTIFICIAL URINE BEFORE AND AFTER RETENTION IN A BLADDER WITH ADDED ILEAL LOOP TO WHICH ONE URETER IS ATTACHED

		BEFORE RETENTION	AFTER RETENTION
Time	min.	0	70
Volume	ml.	250	320
Cl	mEq.	16	26·8
Na	mEq.	15·2	24·0
K	mEq.	5·76	7·38
Urea	mg.	3·25	2·72

ii. There is little or no difference in the relative migration rates of sodium and chloride ions across the ileal loop into the blood. Hyperchloræmic

acidosis is therefore an unlikely consequence of uretero-ileocystoplasty. The standard errors involved, *Figs.* 417–419, are shown in *Table IV*.

2. THE USE OF AN ISOLATED LOOP OF ILEUM AS AN ARTIFICIAL KIDNEY

CASE REPORT

E. H., female, aged 48, when first seen on Sept. 14, 1950, had been in ill health for two to three years. In the last few months she had lost weight, her appetite was poor, and she had frequency of micturition usually twice at night. Shortly before admission she had a fairly severe hæmaturia lasting for ten days.

Table IV.—THE RESULTS DESCRIBED GRAPHICALLY IN FIGS. 417–419 AND THEIR CORRESPONDING STANDARD ERRORS

NUMBER OF BLOOD SAMPLE	FIG. 417		FIG. 418		FIG. 419	
	Na	Cl	Na	Cl	Na	Cl
1	1·30 ± 0·03	2·29 ± 0·09	14·9 ± 0·09	14·2 ± 0·28	1·09 ± 0·04	1·64 ± 0·14
2	2·50 ± 0·03	3·46 ± 0·31	18·7 ± 0·10	14·7 ± 0·28	1·86 ± 0·04	2·85 ± 0·23
3	2·65 ± 0·04	5·09 ± 0·30	21·3 ± 0·15	15·9 ± 0·41	2·965 ± 0·05	3·16 ± 0·64
4			22·4 ± 0·15	15·85 ± 0·52	3·22 ± 0·05	5·72 ± 0·83

PHYSICAL EXAMINATION AND INVESTIGATIONS.—The right kidney was very considerably enlarged; the left kidney was slightly enlarged. She looked ill and pale. The urine gave a scanty growth of *B. coli*; there were a few pus cells. The hæmoglobin was 70 per cent and the blood-urea 134 mg. per cent. Intravenous pyelograms led to a diagnosis of congenital cystic kidney, the changes being more advanced on the right side. The patient was given general advice and was seen occasionally in the out-patient clinic.

BLOOD-CHEMICAL INVESTIGATIONS.—

Hæmatocrit	24·5	per cent		
Plasma-protein	7·25	g. per cent	1·0268	sp. g.
Urea	64	mg. N_2 per cent	134	mg. urea per cent
Chloride	91	mEq./L.	531	mg. NaCl ,, ,,
CO_2-combining power	25·5	mEq./L.	56·7	vol. per cent
Sodium	130	mEq./L.	300	mg. ,, ,,
Potassium	5·6	mEq./L.	21·8	mg. ,, ,,
Potassium R.B.C.	87	mEq./L.	340	mg. ,, ,,
Phosphorus	4·8	mEq./L.	8·25	mg. ,, ,,
Calcium	4·5	mEq./L.	9·0	mg. ,, ,,

SUBSEQUENT HISTORY.—She was re-admitted to hospital Dec. 1, 1952. She complained of aching in both loins. Her condition had become worse in recent weeks and she had been confined to bed for the previous eight weeks. She had nausea and occasional vomiting; her appetite was poor. She was unable to do any housework. She was, in fact, in a state of uræmia.

The investigations showed a sodium and chloride deficit, the CO_2-combining power was low normal, and the phosphates were considerably elevated. The patient was far more ill than the above figures would lead one to expect. It was considered that she could not live more than a short time, possibly only a matter of weeks. It was thought that it might be possible to improve the patient's condition by preparing an isolated loop of ileum, which might be irrigated by passing appropriate fluids through it.

AT OPERATION (Nov. 20).—An isolated loop, 4 ft. long, was prepared by the method described in the paper by Pyrah and Raper in this issue (p. 337). Continuity of the small intestine was restored by lateral anastomosis. The two ends of the loop were brought to the surface of the body in each iliac fossa. The seromuscular coat of the intestine was sutured to the parietes of the iliac fossa so as to lessen the chances of intestinal obstruction. The patient made a satisfactory recovery from the operation (*Fig.* 420).

The capacity of the ileum to absorb fats after the operation was estimated by measuring the proportion of unsplit fat which was present in dried fæces. A value of 10 per cent was obtained; this indicated that the absorptive capacity of the ileum for fat had not been appreciably impaired.

SUBSEQUENT COURSE.—The object was to wash out urea and possibly other toxic substances as in Kolff's case (1947); in this case the best value for urea in the irrigating fluid was 5 g. washed out in 10 hours. Difficulties in the irrigation were sometimes found, notably abdominal cramps from spasm of the intestine in the loop; these we have been able to eliminate. Although the amount of urea that we have been able to wash out has not been as great as in Kolff's case, the patient appears to have derived benefits from the periodic irrigation. She has returned willingly to hospital every few weeks for further irrigation and on each occasion there has been clinical improvement. In the last twelve months when she returned to hospital, it was frequently found that she had an electrolyte imbalance, especially an acidosis. This was usually corrected before irrigation was carried out.

It is not the purpose in this paper, however, to present the final results of treatment in this case or to attempt to assess the value of a loop of ileum as a possible artificial kidney. In using different irrigating fluids, it was soon found that it was desirable to know more about the migration of ions, notably sodium, chloride, calcium, and potassium, across the ileal mucosa into the blood. It is the methods which we have used and the results which have been obtained which are now described.

Method.—The isolated loop is perfused with a suitable fluid and transfer of urea and certain ions takes place between the blood and this fluid. Since chemical analyses of the fluid used before and after perfusion give only the net direction and magnitude of the movement of the ions involved, the use of one or more radio-isotopes was suggested as a means

of labelling the movement in one direction. Preliminary experiments with the use of Kolff's solution indicated a loss of potassium by the blood during the accompanying removal of urea. In order to reduce the potassium loss to a minimum, it was decided to investigate the relationship between the movement of this ion between blood and loop and

FIG. 420.—The use of an isolated loop of ileum as an artificial kidney. The two ends of the loop can be seen in the iliac fossa.

the rate of flow and composition of the perfusion fluid. Because of the result obtained by Tasker, interest was also centred upon the direction of movement of potassium when the potassium concentration of the perfusion fluid was considerably higher than that of the corresponding plasma. ^{42}K, the radio-isotope of potassium of half-life 12·4 hours, was used to label the potassium moving from the blood into the loop.

An approximate analysis of a perfusion fluid isotonic with blood indicated that, at a rate of flow of half a litre an hour, there was an excretion of potassium into the loop of about 0·1 g. per litre of fluid. On the basis of this excretion and an assumed total body content of exchangeable potassium of 125 g. the amount of ^{42}K as potassium carbonate to be injected intravenously was calculated. This injection took place at least 14 hours before the commencement of radio-activity measurement, this period being considered sufficient for equilibration of the injected ^{42}K with most of the potassium of the body. Two series of experiments were carried out; for the first we injected 660 μC in 5 ml. sterile solution containing 0·08 g. potassium carbonate, and for the second, half this activity. The counting rates obtained were sufficient to enable us to continue the investigations over two or three days.

The perfusion fluid was run into the proximal end of the loop from a reservoir by way of a calibrated drip and a thermostat kept at body temperature. Thin-walled Foley catheters with inflated balloons inserted 12 cm. at each end of the loop provided the means of entry and exit of the perfusion fluid. Muscular contractions of the walls of the loop were prevented by increasing the flow rate slowly and by the addition at suitable intervals of 5 ml. 5 per cent procaine to the perfusion fluid. The perfusion fluid passed from the patient through a glass vessel surrounding a flow type counter, well screened from the patient. In this way, a continuous record of the counting rate was obtained. In addition, samples were taken for standardization in a type M6 liquid counter and both counters were calibrated with a diluted fraction of the initial fluid. The compositions of the fluids used are shown in *Table V*.

Before any reliable observations could be obtained, the perfusion was continued for about two hours in order to wash out any residual fluid. The rate of flow was then adjusted to some fixed value and the corresponding steady counting rate observed, correction being made for radio-active decay. When the steady rate had been established, 10-ml. samples of the efflux were collected from the flow counter and analysed chemically in order to determine the net transport of potassium across the ileal wall. In this way an accurate indication could be obtained of the movement of potassium at any one rate of flow of known initial potassium concentration. This procedure was employed for a number of different flow rates and different perfusion fluids. With each fluid used, a check was carried out on the volumes employed and the volumes recorded.

Table V.—THE COMPOSITIONS OF FLUIDS USED TO PERFUSE THE ARTIFICIAL KIDNEY

ISOTONIC		HYPERTONIC A	HYPERTONIC B	HYPERTONIC C
Sodium chloride	6·0 g./l.			
Sodium bicarbonate	2·0 g./l.			
Potassium chloride	0·4 g./l.	The isotonic solution plus 0·4 g./l. of potassium chloride	The isotonic solution plus 0·8 g./l. of potassium chloride	The isotonic solution plus 1·2 g./l. of potassium chloride
Glucose monohydrate	15·0 g./l.			
Calcium lactate	0·77 g./l.			
Hydrated magnesium sulphate	0·31 g./l.			
10 per cent CO_2, 90 per cent O_2 to saturation				
Total number of mEq./l.	340·0	350·8	361·6	372·4

Results.—Within the limits of experimental error there were no significant net changes in the volumes of any of the perfusion fluids used except at the very slow rates of flow. At 1 ml. per minute there was some absorption of fluid by the body but since the perfusion rate was so slow, this absorption was in no way dangerous.

a. Correlation between Flow Rate and Counting Rate (Flow Counter).—The counting rate given by the flow counter is a measure of that potassium concentration in the efflux which has been excreted into the loop from the blood. This neglects the ^{42}K which will return across the wall into the blood

in the dynamic interchange but this effect will be very small because of isotopic dilution in the loop. The total amount of ^{42}K excreted via the urine and into the loop is regarded as too small to affect significantly its total concentration in the body during the experiment. Changes in the counting rate thus reflect changes in the movement of potsssium from the blood into the loop. The results of the first series of experiments are shown in *Table VI*.

Table VI.—THE CORRELATION BETWEEN FLOW RATE OF PERFUSION FLUID AND THE EXCRETION OF POTASSIUM BY AN ARTIFICIAL KIDNEY (SERIES 1)

CORRECTED COUNTS/MIN. K	DRIP RATE IN DROPS/MIN. R/0·074	DRIP RATE IN ML./MIN. R	$\frac{KR}{7·4}$	FLUID
1350	73	5·4	987	Isotonic
880	120	8·9	1056	,,
1270	60	4·4	762	,,
1030	110	8·1	1133	,,
530	120	8·9	636	Hypertonic A
720	54	3·9	389	,,
490	155	11·3	1025	Hypertonic B

Values of the drip rate, R/0·074, were plotted against corresponding values of the counting rate K (*Fig.* 421). A linear relationship was obtained for each fluid used. The equation of the curve for the isotonic fluid was :

$$R = -0·00925\,K + 17·25$$

The corresponding results for the second series are shown in *Table VII*.

The equation of the curve representing the use of the isotonic fluid was then

$$R = -0·00419\,K + 15·10$$

If allowance be made for the difference in activities and in time scales for the two series, the results are found to fit reasonably well though exact agreement would not be expected in view of the possible differences in total exchangeable potassium on the two occasions. However, the agreement is considered to be sufficiently close to justify the formulation of a general relationship, for this patient, between the flow rate and the concentration of potassium excreted into the ileal loop.

b. The Relationship between the Flow Rate, the Original Potassium Concentration in the Perfusion Fluid and the Concentration of Potassium excreted into the Ileal Loop.—It was found that reversal of the direction of net flow of potassium usually occurred when the concentration of potassium in the perfusion fluid approximated to or exceeded that of the Hypertonic B fluid.

$$\text{If } x = \frac{\text{the original potassium concentration in the perfusion fluid}}{\text{the original potassium concentration in the isotonic perfusion fluid}}$$

it was found that the results of the two series could be represented by the linear relationship :

$$\frac{K}{R} = 51·5\ x\ -158$$

Combining this with the expression relating flow rate to potassium excretion, we obtained

$$kC = K = (17·25 - R)(158 - 51·5x).$$

This expression gives the relationship between potassium excretion into the loop C, the potassium concentration of the perfusion fluid and its flow rate R, where k is the constant of proportionality between C and K (the observed counting rate). It is only applicable as such when the net movement of potassium is from blood to loop and at the point of equilibrium the relationship breaks down. Beyond this point the dynamic nature of the process is demonstrated by the continued appearance of a radio-active efflux, despite the net absorption by the body of potassium. As would have been expected, this absorption of potassium from the loop appears to be greater at the slower rates of perfusion.

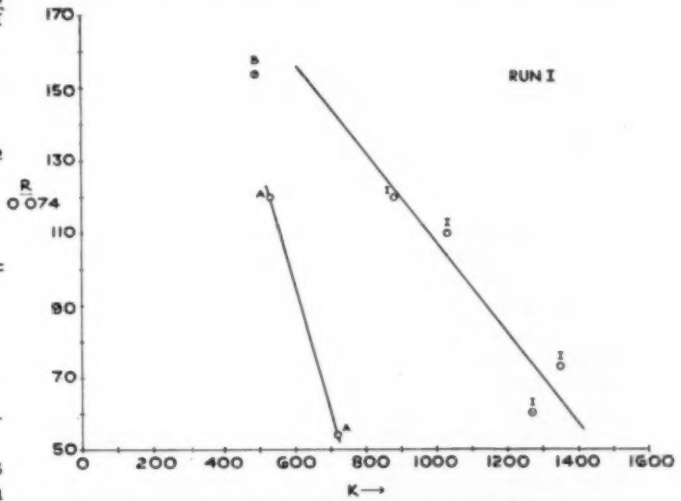

FIG. 421.—The relationship between the drip rate of the perfusion fluid, R/0·074, and the counting rate, K, where K is a measure of the excretion of ^{42}K into this fluid from the blood. I represents the use of the isotonic fluid, A represents the use of the Hypertonic A fluid, and B represents the use of the Hypertonic B fluid.

Table VII.—THE CORRELATION BETWEEN FLOW RATE OF PERFUSION FLUID AND THE EXCRETION OF POTASSIUM BY AN ARTIFICIAL KIDNEY (SERIES 2)

CORRECTED COUNTS/MIN. K	$\frac{K}{2}$	FLOW RATE IN DROPS/MIN. R/0·0617	FLOW RATE IN ML./MIN. R	$\frac{KR}{12.34}$	FLUID
2610	1305	66	4·07	861	Isotonic
2200	1100	91	5·61	1001	,,
1765	883	122	7·53	1077	,,
1460	730	160	9·90	1170	,,
1300	650	152	9·37	990	Hypertonic B
1620	810	66·5	4·10	538	,,
1062	531	80	4·94	424	Hypertonic C

It should be realized that, although the use of the Hypertonic B fluid with a patient having normal potassium figures would result in little or no net movement of potassium, if the figures are subnormal then the Hypertonic B fluid is effectively more concentrated and will serve to drive potassium into the blood (*see Table XI*, example No. 3).

The fact that the direction of net potassium flow can be reversed in this way suggests the possibility of hyperkalæmia arising in a patient with

oliguria, or poor kidney function, if urine be allowed to flow slowly over an area of ileal epithelium.

c. The Determination of the Efficiency of the Artificial Kidney.—

i. *The excretion of potassium into the loop as a function of time*: The curve relating K and R has the general form

$$K = -aR + c$$

where a and c are constants.

Now KR is a measure of the excretion of potassium into the loop per unit time, where $KR = -aR^2 + Rc$.

It can be shown that the maximum value of KR occurs when $R = \frac{c}{2a} = 8{\cdot}6$ ml. per minute.

This means that there is a certain rate of flow for each perfusion fluid at which the loss of potassium into the loop per unit time is a maximum. The results of Series 1 are shown in *Fig.* 422.

It should be noticed that as the original potassium content of the perfusion fluid increases, so does that rate of flow at which the loss of potassium into the loop per minute by the patient is a maximum.

ii. *The excretion of urea into the loop as a function of time*: The percentage urea concentrations in the fluid from the loop and the corresponding flow rates are shown in *Table VIII*. The inverse relationship between them does not appear to be influenced appreciably by the potassium concentration of the perfusion fluid or by the fact that the fluids used differed slightly in osmolarity. The maximum value of the percentage concentration of the excreted urea recorded was 100 mg. per cent. Since this was at a flow rate of 1 ml. per minute of the Hypertonic B fluid, the removal of urea with time was approximately 60 mg./hr.

Kolff obtained an excretion of 480 mg. of urea per hour at a flow rate of 1 litre per hour (16·6 ml./min.) during the use of a similar length of perfused ileum. Our figure of 60 mg. per hour at a flow rate of about 60 ml. per hour seems low in comparison with Kolff's result, but it should be noted that he advocates the use of the artificial kidney only when the blood-urea level of the patient rises above 340 mg. per cent. The corresponding value in our patient was only 140 to 165 mg. per cent and may well account for the smaller urea excretion which we obtained. At this very slow flow rate the movement of potassium with time is far removed from its maximum value, so that it might be concluded that the Hypertonic B fluid at a flow rate of about 1–4 ml. per minute is perhaps the best fluid to use in the perfusion of this particular ileal loop, when the blood-potassium of the patient is normal. Perfusion with the Hypertonic B fluid was tried after the blood cellular potassium of this patient had dropped below normal, this change being unaccompanied by a corresponding fall in plasma-potassium. It resulted in an absorption of potassium by the blood in such a way that the plasma-potassium remained within normal limits whilst the cellular potassium rose to nearly normal. The changes in blood-potassium associated with perfusion of the loop with different fluids are shown in *Table IX*. Throughout each perfusion period the patient was kept on an approximately constant diet, low in both protein and sodium chloride.

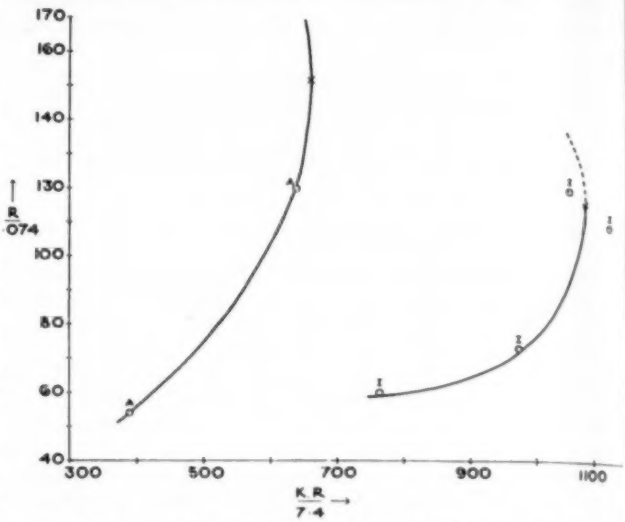

FIG. 422.—The relationship between the drip rate of the perfusion fluid, R/·074, and the excretion of potassium into the loop with time. I represents the use of the isotonic fluid. A represents the use of the Hypertonic A fluid.

Table VIII.—THE EXCRETION OF UREA INTO THE LOOP AT DIFFERENT PLASMA UREA CONCENTRATIONS AND WITH DIFFERENT PERFUSION FLUIDS

Isotonic Fluid Plasma-urea Concentration 164 mg. per cent		Hypertonic B Fluid Plasma-urea Concentration 164 mg. per cent		Hypertonic C Fluid Plasma-urea Concentration 164 mg. per cent		Hyppertonic B Fluid Plasma-urea Concentration 151 mg. per cent		Hypertonic B Approx. Fluid Plasma-urea Concentration 140 mg. per cent	
Flow Rate ml./min.	Urea Concentration in Efflux mg. per cent	Flow Rate ml./min.	Urea Concentration in Efflux mg. per cent	Flow Rate ml./min.	Urea Concentration in Efflux mg. per cent	Flow Rate ml./min.	Urea Concentration in Efflux mg. per cent	Flow Rate ml./min.	Urea Concentration in Efflux mg. per cent
7·21	4·3	9·38	3·1	4·94	4·8	1	53·5	1	100
4·07	5·9	9·38	4·8	5·0	3·8	1	65·0	1	63
5·62	6·1	9·38	1·9	5·0	4·8	1	100·0	1	62·8
5·62	4·7	9·38	1·4	5·0	1·4	1	20·5	1	64·6
7·52	2·9	4·14	6·2			1	27·5	1	62·5
9·90	2·1					1	45·0		

d. Changes in the Composition of the Fluids used during Perfusion.—The changes which took place in the composition of the perfusion fluids after

passage through the ileal loop are shown in *Table X*. The corresponding changes in the plasma-levels of these components are given in *Table XI*.

Comparison of Our Results with Those obtained by Thompson and his Co-workers.—*Chloride.*—Changes in the chloride concentration of the perfusion fluids appear to depend more on the relative potassium concentrations in the perfusion fluid and plasma. The change in potassium concentration is greater the slower the rate of perfusion. The result obtained by Thompson and his co-workers has been verified, viz., there is an excretion of potassium by the body into an *isotonic* perfusion fluid.

Table IX.—Changes in Blood-potassium associated with the Perfusion of an Isolated Ileal Loop

Before Perfusion Blood K mEq./L.		After Perfusion Blood K mEq./L.		Types of Fluid used	Time of Perfusion in Days
Cellular	Plasma	Cellular	Plasma		
86	6·15	83	6·0	Isotonic, then Hypertonic A	2½
—	5·5	—	4·7	Isotonic, then Hypertonic B	2½
78·2	5·26	88·5	4·62	Hypertonic B	3
74·4	3·98	87·1	4·81	Hypertonic B	3

relation between the plasma chloride level and the chloride concentration of these fluids than on their rate of perfusion. Thompson and his co-workers (1952) found no significant changes in the chloride concentrations after passage through the loop.

Sodium.—There appear to be no significant changes in the sodium concentrations of the perfusion fluid used, though Thompson and his co-workers observed a decrease ranging from 2·5 to 12 mEq./l. on passage through the loop.

Potassium.—The movement of potassium between loop and blood has been shown to depend on the enhanced. This absorption is greater at the slower rates of perfusion. Thompson and his co-workers recorded an excretion of calcium by the body in the majority of their experiments, but since in our experiments the calcium concentration in the presence of bicarbonate was maintained by saturating the perfusion fluid with carbon dioxide, the effective concentration of calcium we used was probably greater.

Calcium.—As the calcium concentration of the perfusion fluid is increased relative to that of the plasma, the absoption of calcium by the body is

Table X.—Changes in the Composition of the Fluids used during the Perfusion of an Isolated Ileal Loop

Flow Rate	Na (Mg. Per Cent)			K (Mg. Per Cent)			Cl (Mg. Per Cent)			Ca (Mg. Per Cent)		
	In	Out	Diff.	In	Out	Diff.	In	Out	Diff.	In	Out	Diff.
Isotonic Fluid :—												
7·21	285	290	5	21·8	25·6	3·8	376	365	−11			
4·07	285	297	12	21·8	26·0	4·2	376	376	0			
5·62	285	312	27	21·8	25·5	3·7	376	369	− 7			
5·62	285	300	15	21·8	26·0	4·2	376	364	−12			
7·52	285	303	18	21·8	24·5	2·7	376	373	− 3			
9·90	285	295	10	21·8	23·0	1·2	376	376	0			
Hypertonic B Fluid :—												
9·38	302	295	− 7	65·6	69·0	3·4	417	390	−27			
9·38	302	295	− 7	65·6	67·6	2·0	417	390	−27	1·3	1·5	+ 0·2
9·38	302	302	0	65·6	68·0	2·4	417	418	+ 1			
9·38	302	300	− 2	65·6	65·6	0	417	428	+11			
4·14	302	300	− 2	65·6	63·2	−2·4	417	411	− 6			
Hypertonic C Fluid :—												
4·94	300	310	10	86	80	− 6	436	418	−18			
5·00	300	305	5	86	82	− 4	436	418	−18			
5·00	300	290	−10	86	84·4	− 1·6	436	414	−22			
5·00	300	300	0	86	83	— 3	436	421	−15			
Approximate Hypertonic B Fluid :—												
1	265	296	31·0	64	64	0	421	442	21	14	9·3	− 4·7
1	265	297·6	32·6	64	49	−15	421	429	8	14	8·7	− 5·3
1	265	296·4	31·4	64	44	−20	421	470	49	14	7·2	− 6·8
1	265	292	27·0	64	49	−15	421	452	31	14	8·1	− 5·9
1	265	284	19·0	64	60	− 4	421	456	35	14	9·6	− 4·4
1	265	296	21·0	64	50	−14	421	464	43	14	8·0	− 6·0
Approximate Hypertonic B Fluid :—												
1	284	284	0	69	58	−11	412	421	9			
1	284	276	− 8	69	58	−11	412	405	− 7	25·0	18·3	− 6·7
1	284	272	−12	69	52	−17	412	414	2	25·0	11·6	−13·4
1	284	304	20	69	64	− 5	412	450	38	25·0	14·4	−10·6
1	284	284	0	69	62	− 7	412	408	− 4	25·0	14·4	−10·6

Glucose.—In accordance with the results obtained by Thompson and his co-workers, glucose was found to be absorbed from the loop during the perfusion. The extent of this absorption was greater at the slower rates of perfusion.

Phosphorus.—Thompson and his co-workers demonstrated the movement of phosphorus into the loop from the blood by means of an intravenous injection of disodium hydrogen orthophosphate labelled with ^{32}P. This movement of phosphorus was verified and was found to follow approximately that of urea.

The Effect of Reversal of the Direction of Perfusion upon the Migration of the Components of the Perfusion Fluid.—Approximately six litres of the Hypertonic B fluid were passed through the loop in the reverse direction to that described above at a overall flow rate of approximately 1 ml./min. There did not appear to be any important change in volume during perfusion. *Table XII* shows the changes in the concentrations of the components of the perfusion fluid. They do not appear to differ significantly from those results obtained by perfusion in the conventional direction (*Table X*).

SUMMARY

1. The possibility of a hyperchloræmic acidosis arising from a differential uptake of chloride over sodium ions via a loop of ileum anastomosed to the bladder has been investigated by means of the radio-isotopes ^{24}Na and ^{38}Cl. No such differential uptake has been observed.

It has been shown that sodium and chloride ions migrate under the conditions of our experiment across the epithelium of the excluded bladder into the blood and also in the reverse direction from blood into the experimental fluid within the bladder. Such movement takes place simultaneously in both directions, that is, a dynamic equilibrium exists.

2. An artificial kidney in the form of a perfused loop of terminal ileum is described and a study made of the migration of several ions between blood and loop, with special emphasis laid on the movement of potassium.

Potassium ions have been shown to move simultaneously in both directions across the ileal wall and a relationship between the migration from blood to gut, flow rate, and original potassium concentration of the perfusion fluid is suggested. It has bee

Table XI.—Changes in the Plasma Composition brought about by the Perfusion of an Isolated Ileal Loop

Plasma level: Before Perfusion Na mEq./l	K mEq./l	Cl mEq./l	Ca mEq./l	Urea mg. per cent	After Perfusion Na mEq./l	K mEq./l	Cl mEq./l	Ca mEq./l	Urea mg. per cent	Perfusion Fluid	Time of Perfusion in Days
No. 1											
146	5·5	103	3·15	166	141	4·7	102	3·25	164	Isotonic	1
										Hypertonic B	1
										Hypertonic C	½
No. 2											
134·5	5·26	104·9	2·5	131	137	4·62	101	2·33	151	Hypertonic B	3
No. 3											
139·5	3·98	94	1·65	156	139	4·81	96	2·9	140	Hypertonic B (approx.)	3

Table XII.—Changes in the Composition of the Hypertonic B Fluid used to Perfuse an Isolated Ileal Loop in a Distal to Proximal Direction (mg. per cent)

	Hyp. B Fluid in	Sample of Efflux (1)	Sample of Efflux (2)	Sample of Efflux (3)	Sample of Efflux (4)	Sample of Efflux (5)
Na	280	282	271	274	267	267
K	66·0	67·8	58·9	41·0	56·0	56·9
Cl	422	453	395	395	412	401
P	0·07	1·05	0·49	2·06	0·65	0·53
Ca	12·0	9·2	11·4	6·6	11·2	10·8
Urea	<15	102	44	111	53	89
Glucose	1605	790	1390	720	1140	420
Changes in Concentration after Perfusion :—						
Na		+2	−9	−6	−13	−13
K		+1·8	−7·1	−23·0	−10·0	−9·1
Cl		+31	−27	−27	−10	−21
P		+0·98	+0·42	+1·99	+0·58	+0·46
Ca		−2·8	−0·6	−5·4	−0·8	−1·2
Urea		+100	+40	+110	+50	+90
Glucose		−615	−215	−885	−465	−1185

shown that when the potassium concentration of this fluid is approximately three times that in the plasma of the patient, when the cellular potassium is normal, the direction of net movement of potassium is reversed and it becomes absorbed from the loop. Since the potassium concentration of the perfusion fluid at which the net movement of potassium was reversed and absorption by the blood occurred was generally about half the potassium concentration of an average urine, it seems highly probable that absorption of potassium will take place when a loop of ileum is anastomosed to the bladder. If the function of the kidneys is normal, homeostasis of the potassium could be achieved, but if kidney function is impaired, there is a real danger of hyperkalæmia.

Optimum conditions of potassium concentration and flow rate of perfusion fluid are suggested for the maximal removal with time of urea, accompanied by the minimal interference with the potassium balance. The amount of urea removed by perfusion of the loop was small at the blood-urea levels obtaining in this patient (140–165 mg. per cent), and probably it does not by itself account for the clinical improvement noticed in the patient. The larger amount of urea washed out in Kolff's case was probably related to the much higher blood-urea (340 mg. per cent).

Perfusion brought about no marked net movement of sodium and chloride ions. The direction of net movement of calcium seemed to depend on its concentration in the perfusion fluid in a similar way to that described for potassium.

We desire to thank the authorities at Harwell for their co-operation in making available supplies of radio-isotopes. We also thank Professor F. W. Spiers, of the Department of Medical Physics, University of Leeds, for his interest and advice in this research. We also thank Mr. J. Hainsworth and Miss C. E. Campbell, Department of Photography, St. James's Hospital, Leeds, for the photograph and figures. We are indebted to the members of our Departments who have assisted us with much of the routine work involved in this research.

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THE TREATMENT OF PANCREATIC CYSTS BY INTERNAL DRAINAGE

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PANCREATIC cysts large enough to need treatment are so rare that the number encountered by any one surgeon is small. For this reason the relative merits of the various methods available for handling these cysts cannot be assessed on personal experience alone.

For many years after Gussenbauer (1883) described the successful treatment of a pancreatic pseudo-cyst by marsupialization this was regarded as the treatment of choice. The method has undoubtedly been applied without regard to its limited capacity to provide permanent relief; after marsupialization recurrence of the cyst or persistence of a fistula is common, and one or other of these complications occurred in 7 out of 12 cases referred to by Cattell and Warren (1953). Although the persistence of a sinus is clearly undesirable, this disadvantage has sometimes been underestimated: thus in a review of 33 cases of marsupialized pseudo-cysts, Judd, Mattson, and Mahorner (1931) stated that ". . . no patients returned to the clinic with sinuses that had drained for more than two years".

Internal drainage of cysts offers more immediate relief to the patient. Since Ombrédanne (1911) first used the method, sporadic reports of pancreatic cysts treated by anastomosis to a hollow viscus have appeared. Up to 1952, records of 82 cases thus treated have been traced in the literature, excluding cases treated by implantation of a fistula. Cysts have been anastomosed to the stomach, to the duodenum, to the jejunum, to the gall-bladder, and to the common bile-duct, the stomach having been most often selected (*Table I*). This paper records 3 cases in which cystogastrostomy has been carried out with satisfactory immediate and late results.

Table I.—SITES EMPLOYED FOR INTERNAL DRAINAGE OF PANCREATIC CYSTS*

	Cases
Stomach	41
Duodenum	7
Jejunum	24
Gall-bladder	8
Common bile-duct	2
Total	82

* This table includes cases where the pancreatic duct has been implanted into the viscus but not those in which a fistulous track has been utilized.

CASE REPORTS

Case 1.—Female, aged 48. About the end of 1942 this patient noticed a swelling in the left upper quadrant of the abdomen. The mass seemed to vary in size and

FIG. 423.—*Case* 1. Section of wall of pancreatic cyst, showing lining of tall columnar epithelium, with transition from columnar to flattened epithelium towards the lower left-hand corner of the field. The supporting vascular connective tissue contains a few ducts, but no pancreatic acinar or islet tissue. H. and E. (× 45.)

FIG. 425.—*Case* 1. Barium meal four weeks after cysto-gastrostomy. Lateral view demonstrating the persistence of a large retrogastric mass. The site of the stoma is seen on the posterior wall of the stomach. Barium has not entered the cyst.

to pulsate, with the onset of flatulence and pain in the swelling when it became larger. These attacks were not related to meals and were not associated either with anorexia or with change in bowel habit. In March, 1943, when she was first admitted to hospital elsewhere, she had had four such attacks, each lasting one day. At that time examination showed a stout woman in good general condition. There was a mass in the left upper quadrant of the abdomen, round in shape, and estimated

FIG. 424.—*Case* 1. Barium meal four weeks after cysto-gastrostomy. Anteroposterior view showing the site of the stoma near the greater curvature.

as "about the size of an orange". Its lower border was well defined, but the upper border extended beneath the left costal margin. It was of firm consistence, not tender, and did not move on respiration. Radiographs after a barium meal showed a soft-tissue shadow above the transverse colon to the left of the median line. The

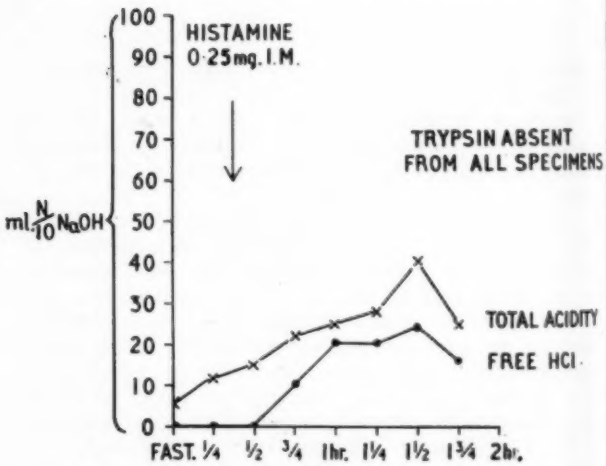

FIG. 426.—*Case* 1. Post-operative fractional test-meal.

mass displaced the body of the stomach upwards and to the right, the jejunum downwards and to the right, and the distal transverse colon downwards. The clinical diagnosis was pseudo-cyst of the pancreas.

FIRST OPERATION (March, 1943).—A large cyst arising from the pancreas was found; details were not

recorded of its presentation in relation to the stomach or colon. The cyst was opened and found to be multilocular. The loculi were broken down, a large quantity of clear fluid was evacuated and, after a biopsy had been taken from the cyst wall, the cavity was packed with gauze. The cyst was then marsupialized.

Microscopical examination showed that the cyst was lined by tall columnar epithelium, supported by vascular fibrous tissue in which were a few ducts lined by columnar cells, but no pancreatic acinar or islet tissue (*Fig.* 423).

After this operation the sinus continued to discharge for two years, and the abdominal skin became tender and excoriated. Early in 1945 the discharge became less free, but shortly afterwards the patient noted that the swelling had recurred.

SECOND OPERATION (March, 1945).—A second incision was made into the cyst alongside the old sinus track, which appeared to be almost obliterated, and a large drainage-tube was stitched in position. The discharge continued for almost fifteen months and then ceased. Three months later the patient was referred to the Professorial Unit, the cyst having reappeared.

THIRD OPERATION (September, 1946).—The cyst was exposed through dense scar tissue. It presented between the stomach and the transverse colon. After the anterior wall of the cyst had been cleared and the remains of the sinus excised, the opening in the cyst was anastomosed to the stomach. The opening in the stomach was made on its posterior wall 2·5 cm. above and parallel to the greater curvature. The stoma was 3 cm. long and two tiers of interrupted linen stitches were used both posteriorly and anteriorly. Recovery was rapid and uneventful. Four weeks after operation, a barium meal examination showed that the greater curvature of the stomach was drawn out as though to the stoma, but barium could not be made to enter the cyst (*Fig.* 424). At this time the cyst was still palpable, and it could be demonstrated in lateral radiographs taken after the barium meal (*Fig.* 425).

Seen again after almost six years, the patient stated that the mass had gradually disappeared and that she had remained well. A fractional test-meal showed a low normal acid curve; trypsin could not be detected in the gastric juice (*Fig.* 426). A barium meal showed that, although it could not be palpated, a residual retrogastric mass was present, causing slight forward displacement of the stomach (*Fig.* 427). When last seen, more than seven years after cystogastrostomy, the patient was in perfect health.

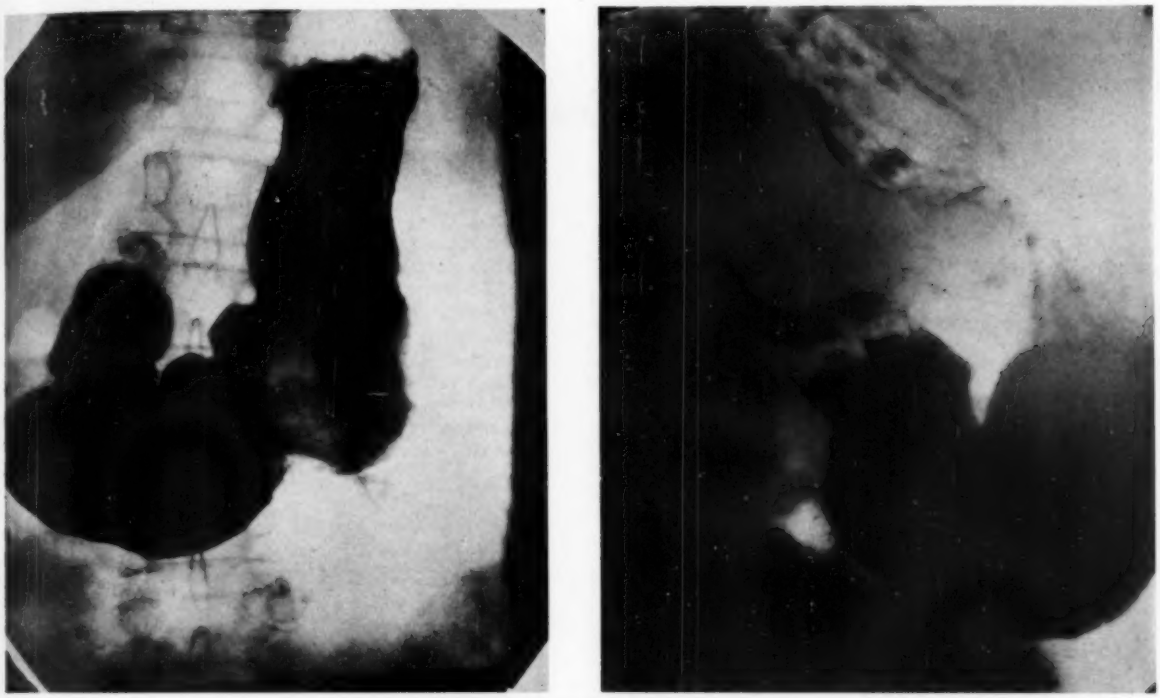

FIG. 427.—*Case* 1. Barium meal seven years after cystogastrostomy. The site of the stoma is still visible and a residual retrogastric mass is shown in the lateral view.

Case 2.—Male, aged 28. In May, 1944, this patient was admitted to another hospital for adjustment of the dosage of thiouracil which had been prescribed for thyrotoxicosis. While in hospital he began to complain of attacks of acute, colicky, epigastric pain. At first the pain was nocturnal, but later it appeared by day also, up to four attacks occurring in 24 hours. The attacks of pain were not related to meals; there was no anorexia; the bowels were regular, and vomiting occurred on only two occasions, each related to an attack of pain. The urine showed a trace of sugar. By August, 1944, the pain had moved to the left hypochondrium, where a small mass was palpable.

FIRST OPERATION (August, 1944).—A smooth dark-red cyst about 14 cm. in diameter was found arising from the region of the tail of the pancreas, to which it was densely adherent over an area approximately 4 cm. in diameter. The cyst was approached through the transverse mesocolon. When excision was attempted the cyst ruptured and discharged fluid containing altered blood. It proved impossible to free the cyst where it overlay the pancreas and its wall was therefore trimmed off around this area. The abdomen was closed without drainage.

Microscopical examination showed the cyst wall to be highly plicated, hæmorrhagic, and densely fibrous. There was an indeterminate lining deep to which were the remains of pancreatic ducts and acini in the midst of dense fibrous tissue. No islet tissue was seen and there was no evidence of malignancy. The patient remained well for five weeks. The abdominal pain then returned and the cyst again became palpable. Radiographs after

a barium meal confirmed the presence of a large retro-gastric tumour displacing the stomach upwards and to the right, and the duodenojejunal junction downwards and to the right (*Fig.* 428).

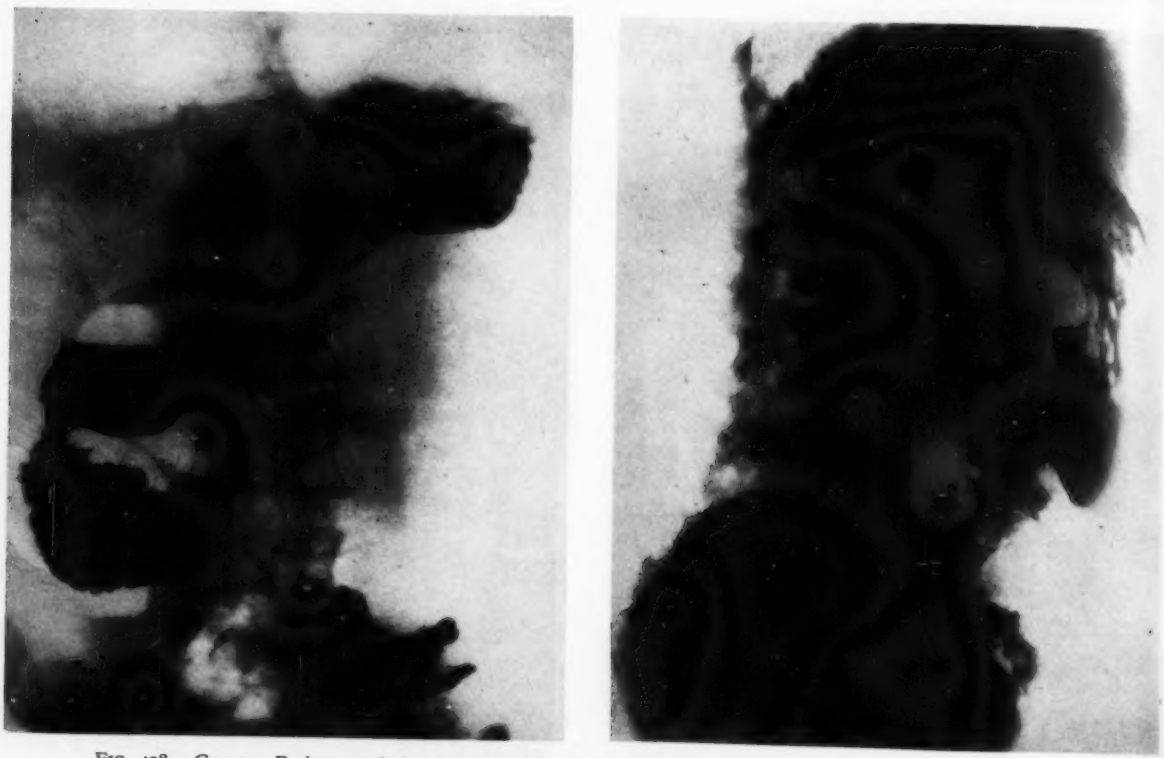

FIG. 428.—*Case* 2. Barium meal showing typical displacement of the stomach and duodenojejunal junction by a large pancreatic pseudo-cyst.

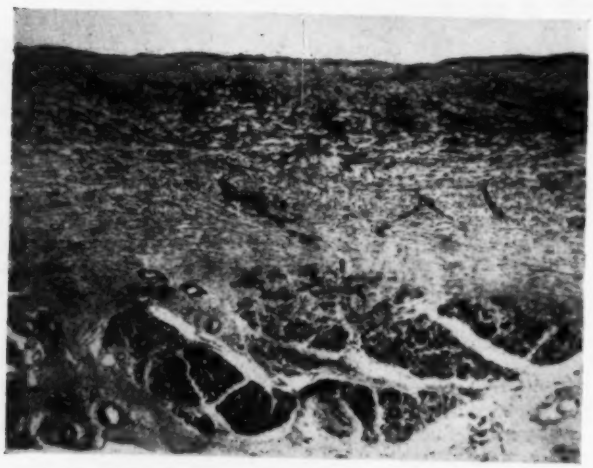

FIG. 429.—*Case* 2. Section of wall of pseudo-cyst. The hæmorrhagic connective tissue contains pancreatic acini and ducts in varying degrees of destruction by the inflammatory process. There is no epithelial lining. H. and E. (× 26.)

SECOND OPERATION (November, 1944).—The cyst, about 15 cm. in diameter, presented to the left of the median line between the greater curvature of the stomach and the transverse colon. Attempts at removal were abandoned when the cyst ruptured. The lining of the cyst was smooth, as though provided by epithelium. The entire lining was carefully dissected away from the deeper layer of the wall without evident damage to the underlying pancreas, a drain was placed in the residual cavity, and the abdomen was closed. Microscopical examination showed the excised lining to be composed of fibrous tissue showing extensive hæmorrhage and

FIG. 430.—*Case* 2. Barium meal 16 days after cystogastrostomy. The incisura on the greater curvature probably represents the site of the stoma, but barium has not entered the cyst.

containing pancreatic tissue of both acinar and islet varieties. There was no epithelial lining (*Fig.* 429). Convalescence was rapid. Complete healing of the wound followed removal of the drain. For one month the patient was well; then vomiting and pain reappeared and a swelling became palpable in the upper abdomen. A barium meal showed the stomach displaced upwards, forwards, and medially, with downward displacement of the duodenojejunal flexure.

THIRD OPERATION (December, 1944).—The cyst was much larger than previously, and was covered anteriorly by the flattened stomach. It was marsupialized. The diastatic activity of the contents was 600 Wohlgemuth units.

During the next two years the patient remained in relatively good health. He put on weight and was free from pain and sickness. However, the sinus continued to discharge an average of 100-120 ml. daily, and the abdominal skin was constantly inflamed and tender. The diastatic activity of the discharge varied from 300 to 500 Wohlgemuth units. The patient never returned to work. At this stage he was referred to the Professorial Surgical Unit.

FOURTH OPERATION (January, 1947).—Through dense adhesions the cyst was dissected free from the anterior abdominal wall. It was found to be presenting between the greater curvature of the stomach and the transverse colon. After the fistulous track had been excised, the opening in the cyst was anastomosed to the adjacent greater curvature of the stomach. A single through-and-through layer of catgut stitches formed the posterior margin of the stoma, the dense adhesions between cyst and stomach making a seromuscular stitch unnecessary. Anteriorly two tiers of interrupted catgut stitches were used. The completed stoma was about 2·5 cm. long. Recovery from operation was uneventful. Two weeks later the patient was up and about and symptom-free. Sixteen days after operation a barium meal (*Fig.* 430) showed deformity of the lower part of the body and proximal part of the pyloric antrum. A small 'tail' of barium was seen on the greater curvature in relation to an incisura proximal to a well-marked pouch. This may have represented the site of the stoma, but barium could not be made to enter the cyst. A fractional test-meal was not carried out in the early post-operative stage, but in 1952 it showed a low normal acid curve (*Fig.* 431). No trypsin was detected in the gastric juice.

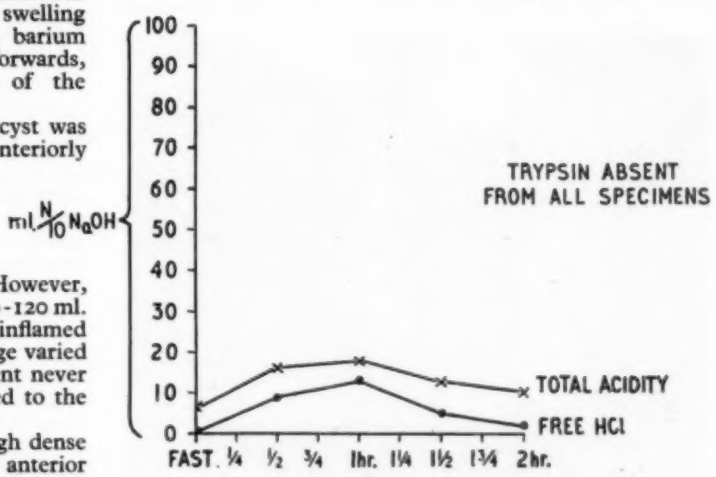

FIG. 431.—*Case* 2. Post-operative fractional test-meal.

FIG. 432.—*Case* 2. Barium meal seven years after cystogastrostomy.

This patient has now been followed up for seven years. He has been free from symptoms and has been continuously employed on heavy work. A barium meal recently carried out showed no abnormality other than persistence of the incisura previously noted (*Fig.* 432).

Case 3.—Female, aged 27. This patient first became ill in November, 1951, when she developed acute, colicky,

abdominal pain of relatively sudden onset. She was admitted to another hospital where a provisional diagnosis of leaking gastric ulcer was made. She improved slowly under treatment by gastric suction, intravenous fluids, and antibiotics. When the acute episode had subsided a barium meal examination was carried out. The only available film (*Fig.* 433) suggests the presence of an extragastric mass deforming the region of the pyloric antrum. From this time onward the patient experienced almost constant upper abdominal pain, gripping in character and radiating to the back and occasionally to the right shoulder. Her appetite was good and the bowels remained regular. When she was referred to the Professorial Surgical Unit in March, 1952, vomiting had become a prominent symptom.

FIG. 433.—*Case* 3. Barium meal. The appearance suggests the presence of an extragastric mass causing an antral filling defect.

Examination showed a thin, pale woman, not in any acute distress, though complaining of pain. An ill-defined, deep-seated, firm, tender mass was palpable in the epigastrium, extending about 8 cm. below the xyphoid cartilage. It was uncertain whether the mass was pulsatile or merely transmitted pulsation, and it did not move with respiration. A straight radiograph of the abdomen showed a slight increase in soft-tissue density in the upper abdomen, but no definite mass was outlined. The clinical diagnosis was considered to rest between pancreatic cyst and aneurysm.

AT OPERATION (March, 1952).—When the abdomen was opened a cystic swelling was found, displacing the stomach forwards and protruding through the lesser omentum and also for 2 cm. below the greater curvature of the stomach. It appeared to be arising from the pancreas. The cyst was opened and about a litre of brownish-coloured fluid was removed. The lining of the cyst was quite smooth. The greater curvature of the stomach was cleared for 3 cm. and an anastomosis was fashioned between cyst and stomach, 3 cm. in length, where the anterior cyst wall was reflected from the posterior wall of the stomach above the greater curvature. One layer of interrupted silk was used posteriorly and two layers anteriorly. Analysis of the cyst fluid showed it to have a diastatic activity of 1600 Wohlgemuth units and strong tryptic activity. The day after operation the patient stated that she felt better than she had done for months, and since then she has never had abdominal trouble of any kind.

Five weeks after operation a barium-meal examination showed a remarkably normal appearance, apart from slight forward displacement of the stomach in the lateral view. The stoma could not be identified, and barium did not enter the cyst (*Fig.* 434). The patient had

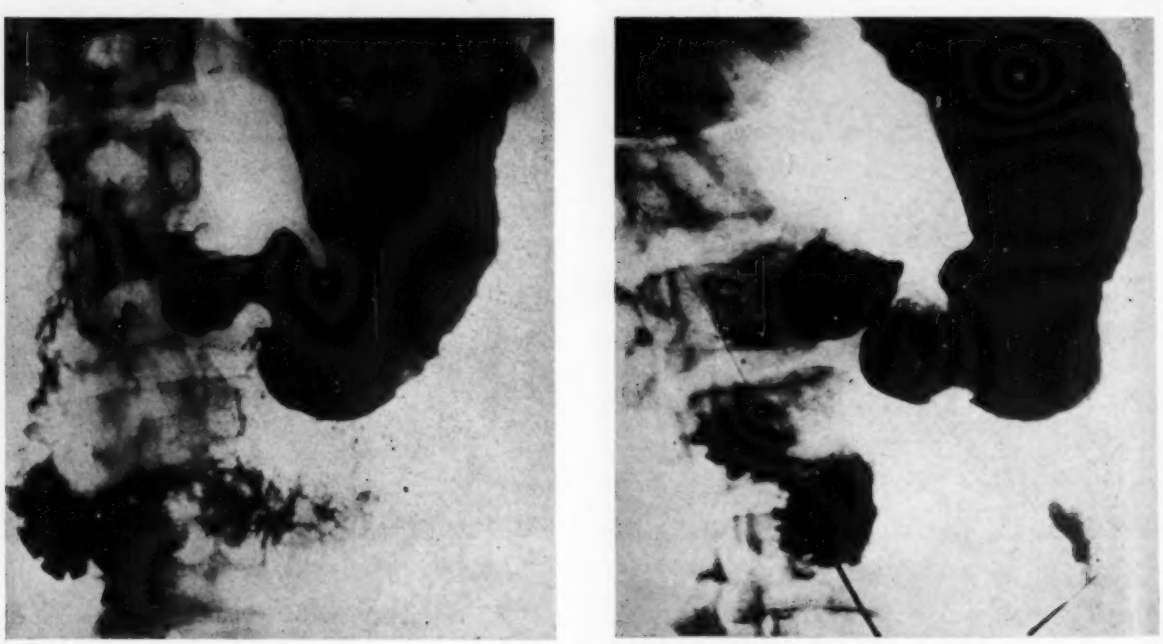

FIG. 434.—*Case* 3. Barium meal five weeks after cystogastrostomy. Slight forward displacement of the stomach persists. The stoma is not visualized and barium has not entered the cyst.

subsequently completed an uneventful pregnancy and was in excellent health when seen two years after operation. Her gastric acidity was low (*Fig.* 435), but trypsin was not detected in the gastric contents.

DISCUSSION

Pathology.—The pathogenesis and classification of cysts in relation to the pancreas have been extensively discussed in the literature. A classification based on that suggested by Mahorner and Mattson (1931) has been widely adopted (*Table II*), and the histological distinction between true and pseudo-cysts is generally accepted. The pathological diagnosis of pseudo-cyst is based on the absence of an epithelial lining. Occasionally a juxtapancreatic hæmatoma may become encapsulated and grow by absorbing fluid because of the osmotic pressure of its hæmolysed contents. Such a pseudo-cystic collection contains practically no pancreatic ferments, and should not persist or recur after drainage unless the density of its fibrous capsule is such as to prevent obliteration of the cavity. However, at some point in their wall most pseudo-cysts have communication with the duct system or secretory tissue of the pancreas. From this area is derived the fluid which distends the cyst or maintains the discharge after drainage. Microscopical examination of this parenchymatous area of the wall of a pseudo-cyst will reveal epithelial tissue. The epithelial elements found in these circumstances lie within the layers of the cyst wall and show ductal or acinar structure (*Fig.* 436). It is most unlikely that such epithelial elements could spread out in an attempt to cover the adjacent granulation tissue wall of the cyst because this behaviour is confined to the covering epithelia of the body surfaces. The detection of an epithelial lining in any area therefore confirms the diagnosis of true cyst. On the other hand, true cysts frequently lose their epithelial lining because of atrophy from increasing tension or as a sequel to infection, so that absence of any epithelial lining is of less diagnostic significance.

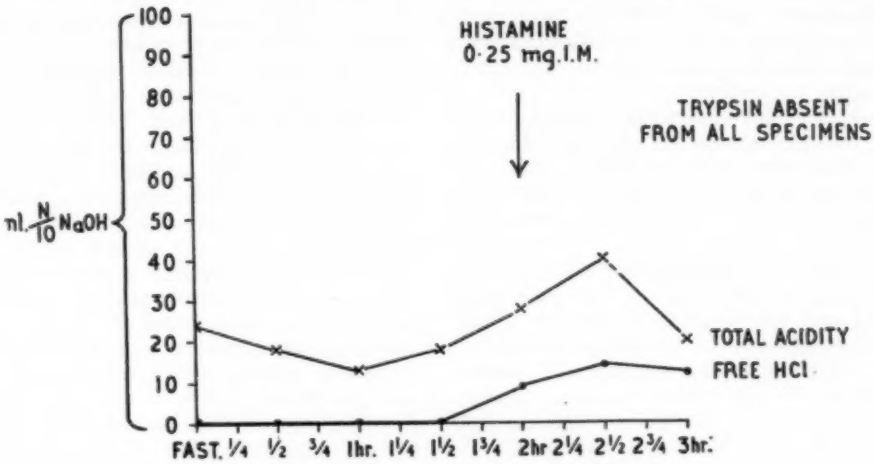

FIG. 435.—*Case* 3. Post-operative fractional test-meal.

Table II.—CLASSIFICATION OF PANCREATIC CYSTS
(*modified from Mahorner and Mattson*)

1. Cysts resulting from defective development :—
   (*a*) Cysts in infants including fibrocystic disease.
   (*b*) Cysts associated with polycystic disease of the kidney.
   (*c*) Dermoid cysts.
   (*d*) Inclusion cysts.
2. Retention cysts.
3. Neoplastic cysts :—
   (*a*) Cystadenoma.
   (*b*) Cystadenocarcinoma.
   (*c*) Teratoma.
4. Parasitic cysts.
5. Pseudo-cysts resulting from :—
   (*a*) Trauma to pancreas.
   (*b*) Inflammation of pancreas.

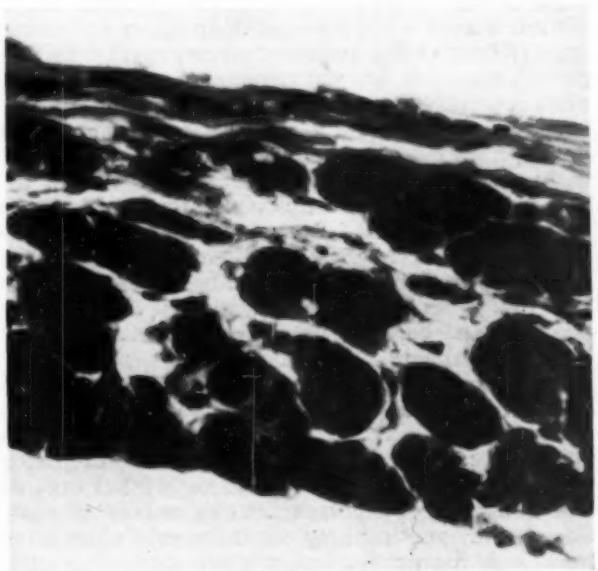

FIG. 436.—Pancreatic secretory epithelium in the wall of a pseudo-cyst. The epithelial cells are in acinar formation and do not form a true cellular lining for the cyst. H. and E. (× 450.) (*From the Laboratory of the Royal College of Physicians of Edinburgh, now the Department of Pathology, University of Edinburgh.*)

Those cysts which the surgeon is called upon to treat are in most instances pseudo-cysts because they are usually the only ones to attain a size sufficient to produce symptoms or abdominal swelling. Nevertheless the clinical significance of a strict

pathological differentiation between true and pseudo-cysts has been overstressed. In *Case* 1 biopsy revealed a lining of tall columnar cells and the condition was probably a congenital cystic malformation, but there were places where the epithelium showed transition to flattened cells (*Fig.* 423) and in time complete epithelial atrophy would doubtless have occurred. In *Case* 2 the cyst lining was acellular. The clinical history, together with the histological findings, leaves no doubt that this was an example of pseudo-cyst following pancreatitis. Although pathologically quite unrelated, both these cases presented in much the same way, both developed similar complications, and both were ultimately cured by the same procedure.

Diagnosis.—The pre-operative diagnosis of pancreatic cyst requires above all that the clinician should bear the possibility in mind when confronted with a patient presenting atypical upper abdominal complaints. Pain is the commonest presenting symptom (Judd and others, 1931; Adams and Nishijima, 1946), and it is usually epigastric, although sometimes radiating to the back. The pain may be constant, dull and aching in character, or it may be episodic and suggestive of recurrent attacks of pancreatitis or associated biliary disease. A history of trauma is obtained in a minority of cases. Symptoms arising from pressure exerted by the cyst on stomach, duodenum, bile-ducts, or colon are so varied as to be in themselves of little diagnostic aid, though they may fit in with other features to suggest the diagnosis. The most reliable single clinical feature is the presence of an upper abdominal mass (Körte, 1898; Judd and others, 1931). Deeply placed, rounded, and not moving on respiration, the mass is usually slightly tender and, as in *Case* 1, may vary in size from time to time. Occasionally a cyst arising from the tail of the pancreas may be surprisingly mobile. Signs of pancreatic or biliary insufficiency such as steatorrhœa, impaired glucose tolerance, glycosuria, or a non-functioning gall-bladder may be sought as additional support for the diagnosis, but they are often absent. By far the most valuable special investigation is radiography following a barium meal, particular diagnostic importance being attached to the lateral view.

Treatment.—If a cyst is large enough to be diagnosed clinically, surgical intervention is always indicated even in the absence of symptoms, because progressive enlargement is to be anticipated with ultimate mechanical interference with other organs. The possibility of rupture must also be kept in mind. Occasionally rupture may occur into the alimentary tract with the production of acute symptoms such as hæmatemesis requiring laparotomy (Pascucci, 1944; Favre and Chippaux Mathis, 1949). Rarely such spontaneous internal drainage may result in complete cure (Bull, 1887; Parsons, 1857; Payr, 1910). More commonly rupture occurs into the peritoneal cavity, producing general peritonitis (Schwartz, 1893; Dixon, 1903; Neuffer, 1932; Koucky, Beck, and Todd, 1941).

While excision of the cyst is the ideal treatment, the operation is frequently hazardous. Cattell and Warren (1953) comment that "local excision is dangerous in terms of possible hæmorrhage or damage to important adjacent viscera and vascular structures. The technical requirements demand great patience and judgement". Distal pancreatectomy may occasionally be used to remove a cyst arising from the body or tail of the pancreas, but this procedure is unlikely to appeal to most surgeons if there is a less formidable alternative.

The most difficult part of the cyst lining to remove or destroy is the posterior wall where it is attached to the pancreas. If this portion is left behind, pancreatic juice will continue to leak into the tissue planes or along the drainage-tube (*Case* 2). Any attempt to destroy this area in situ will do further damage to pancreatic tissue.

The chief problem presented by persistent fistulæ arises not from enzymic digestion of the abdominal skin—for the titre of pancreatic enzymes is usually of a low order—but from simple excoriation and maceration due to the constantly damp dressings if a tube cannot be kept in the track. The loss of pancreatic enzymes is usually only a minute fraction of the total secretion of the gland and usually no systemic upset results from it; occasionally the loss of juice is considerable and its replacement becomes necessary (Cathala and Sénèque, 1930). Internal drainage has the virtue of avoiding any unpleasant dressings or restrictive appliances while restoring the pancreatic juice to the digestive tract.

Anatomical Considerations. — The duodenum would seem to be the most natural site for anastomosis, and indeed it was used in the first recorded case of internal drainage of a pancreatic cyst (Ombrédanne, 1911), but unless the cyst is relatively small and lies in relation to the head of the pancreas in the concavity of the duodenal loop, anastomosis to the duodenum is technically difficult. In most recorded cases the anastomosis has been made to the stomach or jejunum; although the stomach has been used more often, recent reports show a preference for the small bowel. The fashioning of a jejunal loop, whether on the Roux principle or with an entero-anastomosis, is in general a more elaborate procedure than drainage into the stomach. In the majority of cases the cyst will be found presenting between the stomach and the transverse colon. The anterior wall of the cyst is inseparable from the posterior gastric wall up to the line where they diverge near the greater curvature. If an anastomosis is fashioned at this point not only are all 'loops' avoided, but also the posterior seromuscular approximation has already been made by nature. If the operation is being carried out as a primary procedure, an anastomosis can nearly always be made in this position, but where an external fistula already exists it may be more convenient to utilize the cystic end of the fistula (*Case* 1). In these circumstances a double row of sutures will be required posteriorly as well as anteriorly.

In more than half the recorded cases of cysto-gastrostomy a transgastric anastomosis has been made. With this procedure dependent drainage of the cyst is less likely to be achieved than when the greater curvature is utilized. Although dos Santos (1944) regarded this as of secondary importance, he instructed his patient to lie in the prone position for half-an-hour after every meal to facilitate drainage of the cyst cavity. The only possible advantage of the transgastric anastomosis is that the stoma is

surrounded by dense adhesions so that contamination of the peritoneal cavity either at operation or subsequently is rendered doubly unlikely. In practice it has been found that the anastomosis at the greater curvature is secure and can easily be fashioned without contamination occurring.

Physiological Considerations.—

1. *Anastomosis to biliary tract* :—Much has been written on the role played by regurgitation of bile into the pancreatic ducts in the aetiology of pancreatitis, but less attention has been given to the possibility that reflux of pancreatic juice may be a factor in the pathogenesis of cholecystitis (Wolfer, 1931 ; Popper, 1933 ; Colp and Doubilet, 1936 ; Hjorth, 1947). At all events, drainage of a pancreatic cyst into the biliary tract would seem ill advised and the recorded results have been relatively unfavourable (Neuffer, 1932 ; Meyer, Sheridan, and Murphy, 1949), although one 'six-year cure' has resulted from this method (Neuffer, 1939).

2. *Anastomosis to jejunum* : An anastomosis which deprives the upper reaches of the small bowel of pancreatic juice is theoretically undesirable, although as already stated, the discharge from the gland in pancreatic cysts is rarely so large as to raise this issue.

3. *Anastomosis to stomach* : It has been suggested that cystogastrostomy will fail to restore pancreatic enzymes to the digestive tract owing to destruction of the enzymes by gastric juice. This inactivation is not as rapid as many believe. It was found by Spencer, Meyer, Rehfuss, and Hawk (1915) that, at room temperature, trypsin retained its activity for many hours in gastric juice having an acidity equivalent to 110 ml. *N*/10 potassium hydroxide. Long and Muhleman (1914) found that trypsin withstood an acidity of 0·3 per cent hydrochloric acid for 30 minutes at 40° C. I have confirmed these observations *in vitro* for gastric juice of high acidity as well as for varying concentrations of *N*/10 hydrochloric acid (*Fig.* 437). Moreover, pancreatic enzyme replacement therapy is effective by mouth.

One of the principal arguments raised against the use of a gastric anastomosis is the theoretical danger of gastric juice and food particles gaining access to the cyst cavity. It is conceivable that this might precipitate acute pancreatitis. Pancreatitis following cystogastrostomy has in fact been reported in 2 cases. In one of these patients (Mallo and Rossi, 1951) the cyst had developed after an illness clinically suggestive of acute pancreatitis, and it is possible that the second acute attack was not related to the operation. In the second case (Poer and Stephenson, 1949) the patient had no history of pain or trauma before the appearance of the cyst. During the six years after operation there were occasional attacks of mild pain, nausea, and diarrhœa which were ultimately completely relieved by the oral administration of pancreatic extract. Here again the history does not suggest any definite relation to the operation.

Failure of barium to enter the cyst after anastomosis to the stomach is one of the striking features of nearly all the recorded cases in which a postoperative barium meal has been carried out, and it seems likely that food will behave similarly. On the experimental side, implantation of the main pancreatic duct into the stomach in dogs produces no adverse effects on the pancreas over a period of months (Grey, 1917).

The danger to the stomach from pancreatic juice has also been used in argument against cystogastrostomy. Grey did not find any changes in the gastric mucosa in his experiments, and the more recent experimental work of Tripodi and Sherwin (1934),

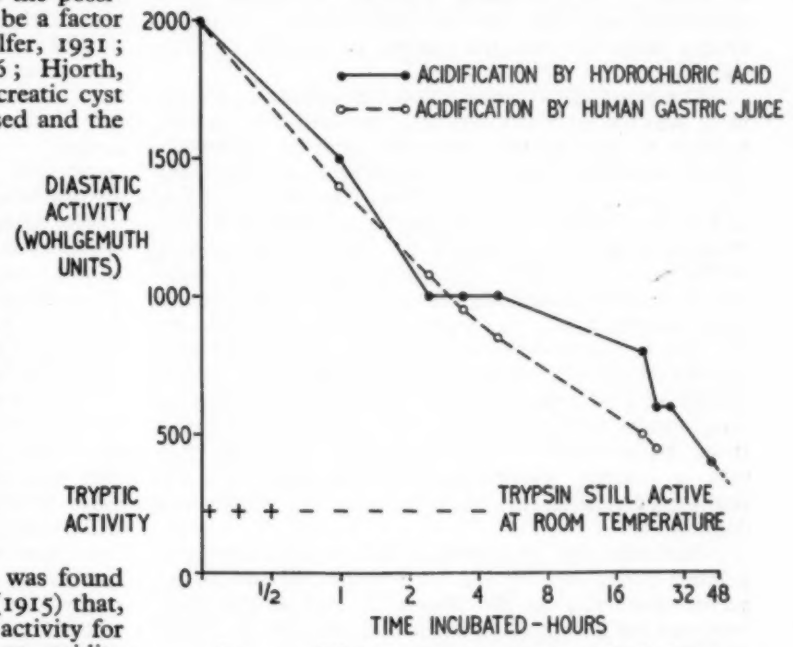

FIG. 437.—Effect on pancreatic enzymes of incubation at 37° C. with hydrochloric acid and human gastric juice, the final acidity in each case being approximately 0·02 N.

Person and Gleen (1939), and Ferguson and Wangensteen (1950), in which the pancreas was implanted into the stomach, yielded similar negative results. An analogous situation arises in cases of pancreatic heterotopia when the abnormally placed pancreatic tissue passes its secretion directly into the stomach, usually through well-developed ducts. Out of nearly 130 such cases recorded in the literature, associated gastric ulceration has been observed in 5 cases (Reimann, 1919 ; Cohen, 1922 ; Wohlwill, 1929 ; Branch and Gross, 1935). Because the contents of pancreatic cysts are usually of much lower enzymic activity than the pure juice, the danger of damage to the stomach should be correspondingly less. Amongst the recorded cases of cystogastrostomy are two in which severe hæmatemesis occurred shortly after operation (Kafka, 1940 ; Maxeiner and Maxeiner, 1950). In Kafka's case death occurred nine days after operation, and at autopsy the bleeding was found to have come from large veins in the posterior wall of the cyst. There was no gastric abnormality. In the other patient seven severe hæmatemeses occurred during the first seven weeks after operation. Following the fourth episode laparotomy was carried out and a posterior gastric ulcer was removed by local excision. Further bleeding occurred nine days later and partial

gastrectomy was carried out after two more hæmorrhages. An active gastric ulcer was demonstrated at the stoma. No mention is made of the enzyme titre of the cyst contents or of the final treatment of the cyst after gastrectomy. This patient had suffered from attacks of upper abdominal pain diagnosed as pancreatitis, but in the absence of a pre-operative barium meal it remains possible that he had a gastric ulcer before operation. Although the association is suggestive, the absence of gastric disturbance in other reported cases, together with our own experience and the relevant observations discussed above, indicates that the danger of gastric damage should not be over-estimated.

The possibility remains that the influx of alkaline juice into the stomach may interfere with the normal acidity of the gastric contents and so adversely affect digestive function. However, it has been shown by Grey (1917) that when the whole volume of bile or pancreatic juice has been diverted to the stomach, there is virtually no fall in the acidity of the gastric contents. The self-regulatory mechanism of gastric secretion is capable of dealing with any such contingency. In pancreatic heterotopia involving the stomach the acidity varies. Only one case associated with complete achlorhydria is on record (Faust and Mudgett, 1940). Altshuler and Meyers (1942) have reported the onset of pernicious anæmia three years after cystogastrostomy, but that this was a chance association is suggested by the finding of achlorhydria before the anastomosis was carried out.

The safety of pancreatico-gastric anastomosis is further borne out by the success of this procedure when employed in the course of partial pancreatectomy for carcinoma (Wells and Shepherd, 1952; Dill-Russell, 1952).

Fate of the Anastomosis.—When a fistulous track or a cyst wall lacking an epithelial lining is used for anastomosis, the possibility of obliteration of the stoma by contracture must be considered. Implantation of an external fistula into the alimentary tract has been followed by recurrence of the cyst in 5 out of 32 cases in the literature. This compares unfavourably with the results of direct anastomosis between cyst and viscus. In the 82 cases reviewed, recurrence has been reported in only 3 cases—a transgastric stab cystogastrostomy (Favres and Chippaux Mathis, 1949); an anastomosis to the gall-bladder (Neuffer, 1932), and an anastomosis to the jejunum (de Bakey, 1951). A fourth case of recurrent cyst following cystoduodenostomy is mentioned by Cattell and Warren (1953). The long fistulous track is particularly liable to obliteration. For this reason, anastomosis of the cyst itself is preferable even where an external fistula has already become established. The fistula can then be safely excised.

Following cystogastrostomy the risk of premature obliteration of the stoma is greatest when drainage has been carried out by a simple stab through the posterior gastric wall, as advocated by Jurasz (1931). If a formal anastomosis is made, the chance of premature closure is greatly lessened. The only recorded case in which obliteration of the gastric stoma has been followed by recurrence of the cyst is one, referred to above, in which stab drainage was carried out; a second operation at which a formal anastomosis was made resulted in complete cure.

In a few recorded cases an opportunity has arisen after months or years to re-examine the anastomosis at operation or by gastroscopy or by gastric photography. In some the anastomosis remained patent (Kerschner, 1935; Waltzel, 1927; Hahn, 1927; Altshuler and Meyers, 1942; Brandenburg, Maddock, and Schweitzer, 1951; Reynolds, 1951). In others the stoma was completely obliterated. Where this was associated with recurrence of the cyst (Favre and Chippaux Mathis, 1949; Neuffer, 1932; de Bakey, 1951), it is evident that secretion was still occurring into the cyst. In Müller's (1948) case, at autopsy seven years after anastomosis, the cyst was not demonstrable and no trace of the stoma was found.

It is a remarkable fact that in no case in which barium studies have been made more than two weeks after operation has barium entered the cyst cavity (Jurasz, 1931; Vecchi, 1935; Josa, 1936; Maske, 1941; Altshuler and Meyers, 1942; Chesterman, 1943; Adams and Nishijima, 1946; Kunc, 1947; Favre and Chippaux Mathis, 1949; Meyer, Sheridan, and Murphy 1949; Poer and Stephenson, 1949; Brandenburg and others, 1951).

In the present series, attempts to produce filling of the cyst from two to five weeks after operation were unsuccessful. Yet in *Case* 1 at this time the cyst was still palpable and disappeared only after three or four months. Favre and Chippaux Mathis (1949) had a similar experience. Where the jejunum has been used for the anastomosis, failure to fill with barium is readily understood, but is less easily explained after anastomosis to the stomach or duodenum. Rössing (1942) suggested that the intra-abdominal pressure and the steady flow of pancreatic juice sufficed to prevent entry of material from the stomach. Intra-abdominal pressure should exert a greater effect on the soft-walled stomach than on the fibrous cyst, while the flow of juice could never possibly be so great as to prevent entry against its stream. In Altshuler and Meyer's (1942) case the lesser curvature was used for the anastomosis, and he suggested that this accounted for the failure of the cyst to fill with barium. On the basis of radiological appearances, Kunc (1947) believed that spasm of the stoma was a factor and that the suction effect of gastric peristalsis tended to produce emptying of the cyst. The most likely explanation would seem to be that the residual cavity rapidly becomes filled by a mass of granulation tissue and organizing clot or exudate.

This effectively prevents the entry of barium (or food) while permitting the escape of a small trickle of pancreatic secretion. That a soft-tissue mass persists even when it is no longer palpable is shown by the lateral radiographs in *Case* 1 of this series and in dos Santos' (1944) case where marked forward displacement of the stomach is seen to remain. Whatever the explanation, these observations lend no support to Cattell's (1952) suggestion that cystogastrostomy is inadvisable as a primary procedure owing to the danger of a large amount of gastric contents accumulating in the cyst cavity.

From time to time it has been suggested that internal drainage should be limited to cysts with

acellular walls. At operation it is rarely possible to be certain from naked-eye appearances alone that one is dealing with a fibrous-walled cyst. It would appear that the result of internal drainage is as satisfactory with the true cyst as with the pseudo-cyst, and the distinction is therefore largely academic except in the case of a cystadenocarcinoma. The routine adoption of internal drainage would carry the potential risk of failure to recognize a malignant cyst which could have been excised. Total surgical excision remains the treatment of choice where this is technically a reasonable undertaking. On the other hand internal drainage is ideally suited to the treatment of a neoplastic cyst which cannot be excised. The first recorded internal drainage of a pancreatic cyst was in fact carried out for what was probably a malignant cyst (Ombrédanne, 1911) and a similar case has been reported by Adams and Nishijima with an excellent palliative result (Cattell and Warren, (1946) 1953). The presence of a malignant cyst should be regarded as an absolute contra-indication to external drainage and an inoperable cystadenocarcinoma as the only absolute indication for internal drainage.

SUMMARY AND CONCLUSIONS

Three cases are presented in which anastomosis of a pancreatic cyst to the stomach has resulted in immediate and lasting clinical cure.

The literature concerning internal drainage of pancreatic cysts has been reviewed. It is concluded that anastomosis to the stomach is the most suitable method and that no valid objections to this site of anastomosis have been put forward on either physiological or clinical grounds.

Implantation of a fistulous track into the alimentary canal is not a satisfactory method of treatment, and in all instances the cyst itself should be directly anastomosed to the stomach. The various techniques are discussed.

Owing to the frequency of prolonged discharge after external drainage of a pancreatic cyst, it is suggested that cystogastrostomy should be the primary line of treatment when the ideal of total excision is deemed unduly hazardous. Both pseudocysts and true cysts are equally amenable to this method of treatment.

Irremovable neoplastic cysts are considered to be an absolute contra-indication to external drainage, but may be successfully palliated by internal anastomosis.

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CONGENITAL INTESTINAL ATRESIA

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DURING recent years reports of individual cases of the successful cure of atresia of the intestine have been reported with increasing frequency. It is, therefore, worth while putting on record a series of these cases in order to evaluate the present difficulties in their surgical treatment and the prospects of their cure.

There are two broad classes of this form of congenital intestinal obstruction: true atresia, where there is complete interruption to the lumen of the bowel; and stenosis, where the lumen is only partially obliterated. In actual practice it is often almost impossible to differentiate the two types as the stenosis may only be wide enough to admit the finest probe and the true type may only be revealed by a careful examinaton in the post-mortem room. It is, thus, more convenient to group the two classes together and indicate how they differ in symptomatology.

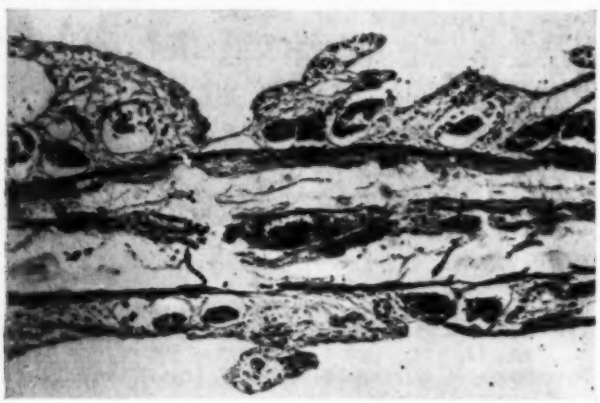


FIG. 438.—Section of septum in case of duodenal atresia.

HISTORY

The condition of duodenal atresia was first described by Calder in 1733, but it was not until 1916 that Ernst, of Copenhagen, reported the first successful operation for its cure, and since that date the number of individual successes has gradually increased. So much is this true that one begins to suspect that the condition is much more common than is believed.

The present series is based on 35 cases of congenital intrinsic obstruction which have been referred to me for operation at the Newcastle General Hospital during the last fifteen years.

A summary of these cases is present in *Tables I, II.*

PATHOLOGY

Congenital atresia or stenosis of the intestine is of developmental origin. Prior to the fifth week of the fœtal life the intestine has a lumen lined with epithelium. During the sixth to seventh weeks the epithelium proliferates and the lumen becomes blocked by this exuberant growth. Later vacuoles appear amidst the solid epithelial growth. These vacuoles coalesce and the intestinal lumen becomes reconstituted. Any arrest of this process may result in defects of the bowel. There may be a complete interruption in the continuity of the bowel which may take the form of two blind ends separated from each other by fibrous tissue, or they may be quite free and some distance apart. In some, the bowel may appear quite normal on its external aspect but internally there is a septum which divides the bowel. A micro-section of such a septum, *Case* 17, is illustrated in *Fig.* 438. It will be seen that the membrane is lined on both sides by mucous membrane and contains a core of submucosa, with two layers of muscularis mucosa beneath each mucous membrane. Where only a partial occlusion is present, stenosis results. This may vary in length from ¼ in. to 1 in. of narrowed bowel of varying diameter to remnants of a membrane. This process may occur in either the small or large intestine, and there are examples of all types in this series. The commonest site for these defects to occur is in the duodenum. (*Figs.* 439, 440.) Cases are less common in the ileum and exceptionally rare in the colon. Multiple atresias may also occur and the bowel may look like "bits and pieces". Like all other congenital anomalies, they may be associated with defects in other parts of the body.

Table I.—OPERATION RESULTS, 1939–54

SITE OF ATRESIA OR STENOSIS	NUMBER OF CASES TREATED	RESULTS	
		DEATHS	RECOVERED
Duodenum	17	5	12
Jejunum	3	1	2
Ileum	7	6	1
Colon	1	—	1
Multiple lesions	7	7	—
TOTAL	35	19	16

CLINICAL FEATURES

Incidence.—Out of 13,180 live births at the Princess Mary Maternity Hospital in Newcastle, 1944–51, there were 5 cases of duodenal atresia; and out of 8372 live births at the Newcastle General Hospital, 1947–52, there was 1 case of duodenal atresia and 2 cases of intestinal atresia, so that one may expect 1 defect of the bowel for every 2500 live births.

Symptoms.—The chief symptom is persistent vomiting which occurs from birth or within the first few days of birth. This vomiting is occasionally projectile, but this may not occur. The vomit nearly always contains bile, as it is exceptional for the site of the atresia to be proximal to the ampulla of Vater.

In cases where the atresia is in the jejunum or ileum, the vomiting is much more pronounced and

the fluid becomes brown, offensive, and fæcal in odour, similar to cases of acute intestinal obstruction, which indeed it is.

As the child is not getting any food through the intestine, after perhaps passing some meconium, constipation results. Where the atresia is in the ileum there is usually complete constipation from birth. Owing to the vomiting, severe dehydration develops with loss of weight.

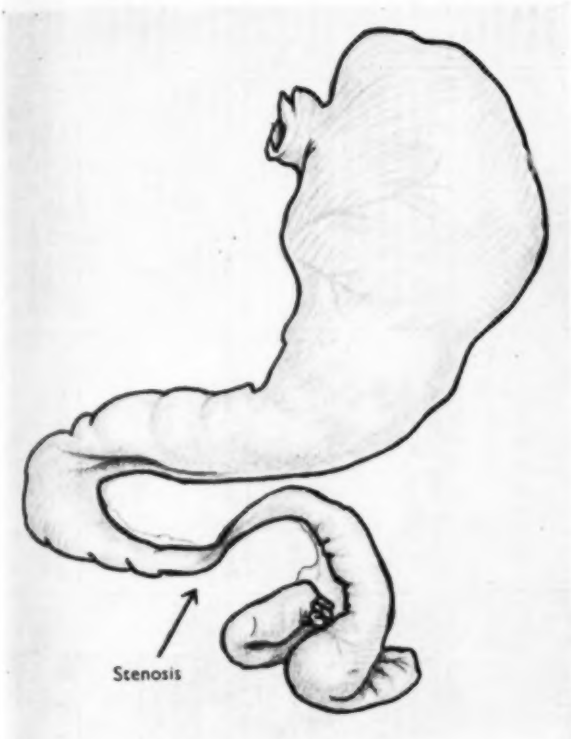


FIG. 439.—*Case* 3. Specimen of duodenal stenosis.

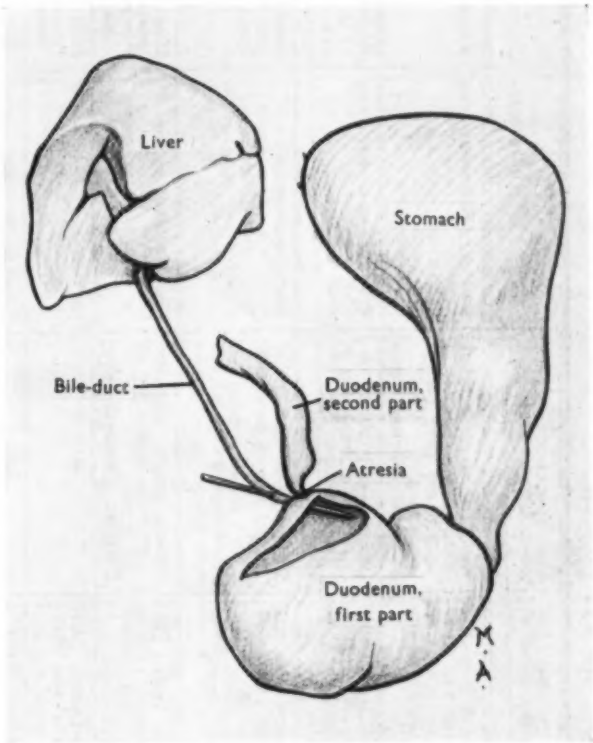


FIG. 440.—*Case* 4. Specimen of duodenal atresia.

Examination of these babies will show in the cases of duodenal atresia some epigastric fullness and occasionally some visible peristalsis, but there were a number of the cases in the series where these physical signs were absent. In some, there was no epigastric fullness, no visible peristalsis, and nothing abnormal to feel.

Occasionally there is some epigastric fullness after a meal which disappears after a copious green vomit. In cases of intestinal atresia there is nearly always early abdominal distension which is tympanitic and sometimes the ladder pattern of acute intestinal obstruction can be seen. These signs and symptoms become modified when stenosis is the pathology.

The differential diagnosis rests between this and other causes of obstruction at birth—malrotation, strangulated hernia, meconium ileus, Hirschsprung's disease, and the odd curiosity—e.g., intussusception.

Congenital pyloric stenosis is rare before the age of 2–3 weeks, the vomit occurs later and is not bile-stained. A tumour can be felt. Any doubts in the diagnosis can be settled by an X-ray examination.

Radiology.—A flat radiograph of the abdomen is all that is necessary to confirm the diagnosis of intestinal atresia. In the normal child the gas shadow in the intestines is present within a few hours of birth. With an atresia of the duodenum, one finds that the gas shadow is limited to the stomach and duodenum. There is no gas in the lower abdomen. Indeed, any newborn child which has persistent vomiting from no obvious cause should have a flat radiograph of the abdomen to exclude an atresia.

The radiologist at the hospital—Dr. Harlan—usually supplemented this investigation by combining with it a barium meal, using thin barium. (*Figs.* 441, 442, 443.) No ill effects occurred in the series. The barium meal is quite conclusive and an accurate picture of the type and site of the atresia can be obtained. Films should be taken in both antero-posterior and lateral positions. The latter is often the more helpful.

An additional test by Farber has been described. This depends upon the isolation of the vernix cells from the meconium. One of the constituents of the amniotic fluid is the desquamated squamous epithelial cells from the skin of the fœtus. The fœtus swallows the amniotic fluid and these cells will be present in the meconium of the normal baby; where, in a suspected case of atresia, these cells cannot be identified, there is the strong supporting evidence than an atresia is present. This test was found of some value in one case of the series. We rely mainly on the history, clinical examination, and X-ray appearances.

PROGNOSIS

Unless the child has an early operation to relieve the obstruction, the result will be fatal. With an operation, in the case of duodenal atresia the outlook

Table II.—SUMMARY OF CASES

Case No.	Date of Admission	Age at Operation	Birth Weight	Admission Weight	Symptoms and Signs	Radiography	Operation	Result
1 A. P.	Dec. 2, 1949	11 days	7 lb. 4 oz.	6 lb. 4 oz.	Bile-stained vomit from third day. No projectile vomit. Vomits directly after feed. Constipated. Epigastric fullness	Barium meal: Complete obstruction at junction of second and third part of duodenum. Diagnosis: Duodenal atresia	Posterior gastro-enterostomy	Recovered
2 J. H. M.	Feb. 22, 1940	9 days	8 lb.	7 lb. 8 oz.	Vomiting from second day. Bile-stained vomit. No fullness in epigastrium. No visible peristalsis	Barium meal: Partial obstruction of duodenum at jejunal junction. Diagnosis: Stenosis	Posterior gastro-enterostomy	Recovered
3 M. C.	July 20, 1942	7 days	6 lb. 11 oz.	5 lb. 8 oz.	Bile-stained vomit from fifth day. Visible peristalsis. Grossly dehydrated. Sometimes projectile vomit. Constipated after passage of meconium	Barium meal: Stenosis of second part of duodenum	Gastro-enterostomy	Died. Technical error—Too big loop for gastro-enterostomy. (Specimen illustrated)
4 S. D.	Sept. 30, 1942	8 days	—	—	Vomited from birth. Epigastric fullness. Passed meconium. No visible peristalsis	Barium meal: Complete obstruction second part of duodenum Diagnosis: Duodenal atresia	Gastro-enterostomy	Died suddenly 1 day after operation. *Post-mortem*: No cause of death. (Specimen illustrated)
5 J. W.	June 21, 1943	4 days	—	—	Complete constipation. Abdomen distended and tense	—	Ileostomy	Died. Post-mortem: Whole of large bowel was a white solid cord
6 E. H.	June 11, 1945	1 day	4 lb. 3 oz.	4 lb. 3 oz.	Admitted with exomphalos	—	Laparotomy: Sac opened and length of isolated intestine found. Portion of atretic bowel found in peritoneal cavity	Died Post-mortem: The portion of bowel outside of abdominal cavity and in exomphalos was almost whole of small intestine. An atretic colon ended blindly in vicinity of duodenum. In the mesentery was a segment of isolated bowel 1 in. long
7 F. M.	Aug. 31, 1945	4 days	8 lb.	—	Repeated vomiting from birth. Abdomen distended. No visible peristalsis. Per rectum about 1½ in. from anus stricture felt	Barium meal: Suggestive of duodenal atresia	Laparotomy: Jejunum ended blindly 1 in. from duodenojejunal junction. Rest of bowel like a string of sausages. Colon solid cord. Operation abandoned	Died No post-mortem
8 G. T.	Feb. 12, 1945	9 days	6 lb. 5 oz.	5 lb. 3 oz.	Vomiting began from third day. Vomit projectile and contained bile. Epigastric fullness	Barium meal: Duodenal stenosis	Gastro-enterostomy	Recovered
9 E. M. H.	March 4, 1946	9 days	5 lb.	4 lb. 2 oz.	Vomited from birth. Bile-stained. No meconium present. Poor general condition. Weak dehydrated baby	Barium meal: Duodenal atresia	Duodenum ended blindly at middle of third part. Jejunum began in a filmy thread. Gastro-enterostomy performed	Did well for a week and then showed signs of deterioration and died suddenly Post-mortem: Satisfactory anastomosis of free blind end of jejunum to stomach. Volvulus had developed involving jejunum, ileum, and colon as far as splenic flexure
10 P. M. C.	May 30, 1946	6 days	8 lb.	6 lb. 11 oz.	Began vomiting 16 hours after birth – green vomit passed meconium. Said to be blood in vomit. O/E wasted and dehydrated	Barium meal: Duodenal atresia	Duodenojejunostomy for atresia of second part of duodenum	Recovered
[illegible]	[illegible]	1 day	5¼ lb.	—	Vomited from birth. Bowels	—	Laparotomy: Atresia of jejunum present. Attempt	Died 5 days later. Peritonitis. Incision in bowel had leaked

11 O. M.	July 12, 1946	1 day	5½ lb.	—	Vomited from birth. Bowels never opened. O/E epigastric fullness. Visible peristalsis present	—	Laparotomy: Atresia of jejunum present. Attempt made to perforate septum and avoid anastomosis	Died 5 days later. Peritonitis. Incision in bowel had leaked. There was a small passage-way through but very little had passed along. Lumen probably inadequate
12 W. S.	Aug. 31, 1948	1 day	—	—	Admitted with abdominal distension and vomiting and absolute constipation. O/E massive visible peristalsis. Abdomen: marked distension. Per rectum: Obstruction at 1½ in.	—	Laparotomy showed 2 areas of atresia in ileum. Colon was a small fibrotic structure 7 in. long. Ileostomy	Died following day Post-mortem refused
13 M. G.	Nov. 5, 1948	7 days	4 lb. 4 oz.	3 lb. 9 oz.	Vomited everything since birth. Sometimes projectile. Passed meconium. O/E feeble dehydrated baby. Upper abdominal distension. No visible peristalsis. Per rectum nil	Barium meal: Suggests a left diaphragmatic lesion with volvulus of stomach	No evidence of hernia. Duodenal atresia present. Posterior gastro-enterostomy	Recovered
14 J. L.	March 8, 1949	18 days	6 lb. 4 oz.	5 lb. 4 oz.	Vomited from second day of birth. Green vomit. Dehydrated and wasted	Barium meal: Barium held up in grossly dilated duodenum. Probably duodenal stenosis	Posterior gastro-enterostomy for duodenal stenosis	Recovered
15 I. T	April 5, 1949	11 days	7 lb. 14 oz.	6 lb. 3 oz.	Vomited from birth. O/E dehydrated. Visible peristalsis	Barium meal: Showed dilated coils of small bowel	Laparotomy: Operation abandoned owing to many anomalies of bowel	Post-mortem: Gross anomaly of large and small bowel; distance from pylorus to rectum 61 cm.
16 G. W.	Aug. 17, 1949	2 days	6 lb. 12 oz.	5 lb. 8 oz.	Vomited from birth. Bile-stained. Abdominal distension. Stomach prominent in epigastrium. Ladder pattern of bowel	Flat radiograph: Gas-filled bowel with fluid levels	Gangrenous volvulus of a loop of small bowel and atresia of jejunum. Resection of gangrenous loop and side-to-side anastomosis	Recovered
17 A. C.	April 26, 1949	8 days	7 lb. 12 oz.	6 lb.	Vomited from fourth day and now persistent vomiting. Respiration 50-60. Fits. Blood-urea 280. Head retracted. Probably cerebral hæmorrhage	Barium meal: Duodenal atresia	Laparotomy: Stomach and duodenum appeared. No atresia demonstrated, but probe passed along course of duodenum where atresia was thought to be	Died. Post-mortem: Intracranial hæmorrhage. Duodenal atresia. Probe puncture would have been inadequate
18 J. Mc.	Nov. 6, 1949	3 days	5¾ lb.	5½ lb.	Vomited from birth. Vomit fæcal. Passed meconium. O/E abdominal distension. Hard and tympanitic	Radiograph: Loops of distended bowel. Atresia of ileum	Two blind ends of ileum demonstrated. Well separated. Bowel anastomosed above and below atresia: Bowel above atresia grossly distended but viable	Died 12 hr. after operation. Post-mortem: Anastomosis patent and no leakage. Fibrocystic disease of pancreas. Atelectasis of lungs
19 J. J.	Dec. 13, 1949	1 day	7½ lb.	—	Bile-stained vomit from birth. Passed no meconium. O/E distended abdomen. Visible peristalsis	Radiography: Dilated loops of small bowel	Ileum terminated blindly within 6 cm. of cæcum and attached by fine cord to cæcum. Terminal 3 in. of proximal end congested and gangrenous and had perforated. This was resected and side-to-side anastomosis between ileum and cæcum	Died suddenly inexplicably 11 hr. after operation. Post-mortem: No definite cause – anastomosis intact
20 L. W.	June 1, 1950	13 days	5½ lb.	5 lb.	Vomited from birth. Green vomit. O/E small baby. No distension	Barium meal: Nearly complete obstruction at junction of second and third part of duodenum	Dilated proximal duodenum with minute distal end. Gastro-enterostomy	Recovered

Table II.—SUMMARY OF CASES—*continued*

CASE NO.	DATE OF ADMISSION	AGE AT OPERATION	BIRTH WEIGHT	ADMISSION WEIGHT	SYMPTOMS AND SIGNS	RADIOGRAPHY	OPERATION	RESULT
21 J. W.	Aug. 22, 1950	(1) 5 days (2) 7 days	6 lb. 12 oz.	5 lb. 10 oz.	Vomited persistently from third day. Green vomit. Meconium passed. O/E pale, weak, restless, and dehydrated. No abdominal distension. Farber's test—positive	Flat radiograph: Stomach and duodenum distended with gas and none beyond third part duodenum. Barium meal: Duodenal atresia	Duodenojejunostomy. (1) For duodenal atresia. Radiograph following day showing gas in stomach and duodenum only (2) Abdomen re-opened and Ryle's tube passed down œsophagus and through anastomosis	Recovered
22 J. S.	Aug. 24, 1950	27 days	9 lb.	7 lb. 11 oz.	Abdomen distended from birth. Vomited dark green material repeatedly from birth. Has passed meconium. O/E uniformly distended abdomen. Tympanitic. Cyanosed on exertion. Diagnosed as stenosis. Treated expectantly at first	Flat radiograph: Distension of bowel with fluid levels. A small amount of air in colon Barium enema: N.A.D.	Stenosis in distal ileum. Bowel ballooned just above and collapsed below. Stenosed portion about 1 in. long thickened and fibrous—minute lumen. Side-to-side anastomosis performed	Recovered
23 R. M.	Sept. 11, 1950	(1) 7 days (2) 11 days	6 lb. 3 oz.	5 lb.	Persistent vomiting from fifth day. Passed meconium. O/E epigastric distension after feed—disappeared after bile-stained vomit	Flat radiograph: Distended stomach and duodenum. No gas in bowel. Provisional diagnosis of duodenal atresia	(1) Showed greatly distended stomach and duodenum. Collapsed jejunum but pressure in stomach could distend jejunum. No anastomosis done. Thought to be due to spasm (2) After 3 days second radiographs: I.S.Q. and so duodenojejunostomy	Recovered
24 S. W.	Sept. 13, 1950	6 days	9 lb.	7 lb. 6 oz.	Vomited green fluid from birth. Passed meconium. O/E distension of upper abdomen	Flat radiograph: Air in stomach and duodenum only. Duodenal atresia	Distended stomach and proximal half of duodenum. Remainder of bowel collapsed. Posterior gastro-enterostomy	Recovered
25 S. H.	Nov. 17, 1950	3 days	7 lb.	—	Vomited green fluid from birth. O/E an ill, dehydrated child. Abdomen grossly distended. Ladder pattern	Flat radiograph: Dilated stomach duodenum, and jejunum with air and fluid levels. No gas in remainder of bowel	Laparotomy: Large dilated jejunum ended blindly. Multiple atresias in rest of small bowel. No anastomosis possible	Died
26 D. G.	Feb. 3, 1951	2 days	7 lb.	—	Copious green vomitus from 12 hr. No meconium passed. O/E distended abdomen. Visible peristalsis	Flat radiograph: Fluid level in upper abdomen	Laparotomy: Atresia in lower third of ileum. Side-to-side anastomosis	Died Had convulsion 4 hr. after operation and died following day Post-mortem: Anastomosis satisfactory; severe hæmorrhage into medulla of kidneys
27 T. I.	May 30, 1951	(1) 1 day (2) 5 days (3) 8 days	9 lb. 8 oz.	—	Vomiting from birth. No meconium passed. O/E distended abdomen. Fæcal vomiting	Flat radiograph: Numerous fluid levels. Distended bowel	(1) Bile-stained fluid in peritoneal cavity. Ileum terminated in an enormously distended blind end minute distal end. Lateral anastomosis performed (2) As obstruction persisted, the abdomen was re-opened and anastomosis remade (3) Obstruction persisted and ileostomy performed	Died Peritonitis due to leakage
28 M. H.	March 27, 1952	(1) 12 days (2) 20 days	9 lb.	7 lb. 1 oz.	Vomited from second day. Vomiting persisted after the	Stenosis in third part of duodenum	(1) Gastro-enterostomy for duodenal stenosis	Recovered

28 M. H.	March 27, 1952	(1) 12 days (2) 29 days (3) 31 days	9 lb.	7 lb. 1 oz.	Vomited from second day. Vomiting persisted after the first operation and after the second	Stenosis in third part of duodenum	(1) Gastro-enterostomy for duodenal stenosis (2) Ryle's tube passed through anastomosis (3) Duodenojejunostomy performed and adhesions divided	Recovered
29 L. P.	Sept. 27, 1952	4 days	7½ lb.	—	Vomited from birth. Vomit—green. No meconium passed. O/E distended abdomen	Distended bowel with fluid levels	Small bowel greatly distended and adherent with plastic peritonitis. Ileum ended blindly 6 in. from ileocæcal junction. Ileum anastomosed to transverse colon	Died
30 C. C.	Oct. 11, 1952	3 days	4 lb. 12 oz.	4 lb. 13 oz.	Vomited from birth and passed no meconium. O/E dehydrated. Distended abdomen and cyanosed	Flat radiograph. Large gastric gas shadows and duodenal cap gas shadows. No gas elsewhere	Gastro-enterostomy	Died suddenly, 12 days later Post-mortem: Duodenal atresia. Congenital heart. Mongol. Hæmorrhagic bronchopneumonia. Anastomosis satisfactory
31 A. M.	March 13, 1953	2 days	5 lb. 14 oz.	5 lb. 3 oz.	Vomited from birth—green. Slight upper abdominal distension	Flat radiograph: Gas in stomach and duodenum but none in small or large bowel Barium meal: Suggested malrotation of bowel with obstruction at duodeno-jejunal junction	Operation: Duodenum distended, whole of small bowel rotated twice on mesentry. When rotation was undone there was only a fine thread connecting the duodenum and jejunum, so duodenojejunostomy	Recovered
32 R. M.	May 14, 1953	4 days	4 lb. 9 oz.	4 lb.	As the mother had hydramnios a watch was kept on the baby when born - not fed for 36 hr. Vomited brown fluid and continued to vomit. Passed meconium. Good general condition	Flat radiograph: Air in stomach only Barium meal: Complete duodenal obstruction	Gastro-enterostomy for duodenal atresia	Recovered
33 E. F.	July 15, 1953	1 day (32 hr.)	5 lb. 15 oz.	—	Mother had hydramnios. Infant dribbled from birth. Attempt made to pass catheter into stomach, but it was arrested at 4½ in.	Radiograph: Blind upper œsophageal pouch with tracheo-œsophageal fistula and air passing beyond stomach. Two conditions diagnosed: (1) Œsophageal atresia (2) Duodenal atresia	Gastrojejunostomy and gastrostomy. Attempt made to join two portions of œsophagus, but only posterior wall repaired. Catheter left in as a splint. (This part of operation by a thoracic surgeon)	Died on twelfth post-operative day. Deeply jaundiced Post-mortem:— (1) Right pneumothorax (2) Duodenal atresia (3) Atresia of bile-duct
34 P. H.	Sept. 23, 1953	3 days	—	—	Vomited all feeds from 24 hr. Vomit bile-stained. O/E dehydrated. Distended abdomen with frequent bile-stained vomits. Local examination—systolic murmur	Flat radiograph: Gas in stomach and duodenum; none in intestine	Found to have an atresia in lower ileum. Lateral anastomosis	Died suddenly the following day Post-mortem: Congenital heart. Aorta and vena cava opened out of right ventricle. Anastomosis satisfactory
35 L.	Oct. 15, 1953	(1) 3 days (2) 36 days (3) 48 days (4) 55 days	6 lb.	—	Vomiting since birth. Bile-stained vomit. No passage of meconium. O/E general distension of abdomen. Appears to be an obstruction about 1½ in. from anus on rectal examination	Radiograph: Atresia in pelvic colon	(1) Transverse colostomy (2) Lateral anastomosis (3) Relief of acute intestinal obstruction due to adhesions of small intestine with colostomy (4) Resection of fæcal fistula and anastomosis (5) Closure of colostomy	Recovered

is quite good. If the condition is diagnosed early and suitable pre- and post-operative treatment is given, the recovery rate should be about 75 per cent. The outlook for atresia of the ileum or colon is not so favourable.

FIG. 441.—*Case* 1. Barium meal showing duodenal atresia.

FIG. 443.—*Case* 1. Patient at age of 14 years.

TREATMENT

There is only one form of treatment to ensure success and that is a surgical operation, but the baby must be made fit for surgery.

When admitted to hospital they are usually greatly dehydrated, pale, weak, and limp, and this state must be overcome by suitable intravenous drips of saline or blood. The blood chemistry must be investigated and suitable treatment given. The stomach should be decompressed by aspiration through a fine duodenal tube.

Anæsthetic.—We have found that the most suitable anæsthetic has been open ether plus oxygen.

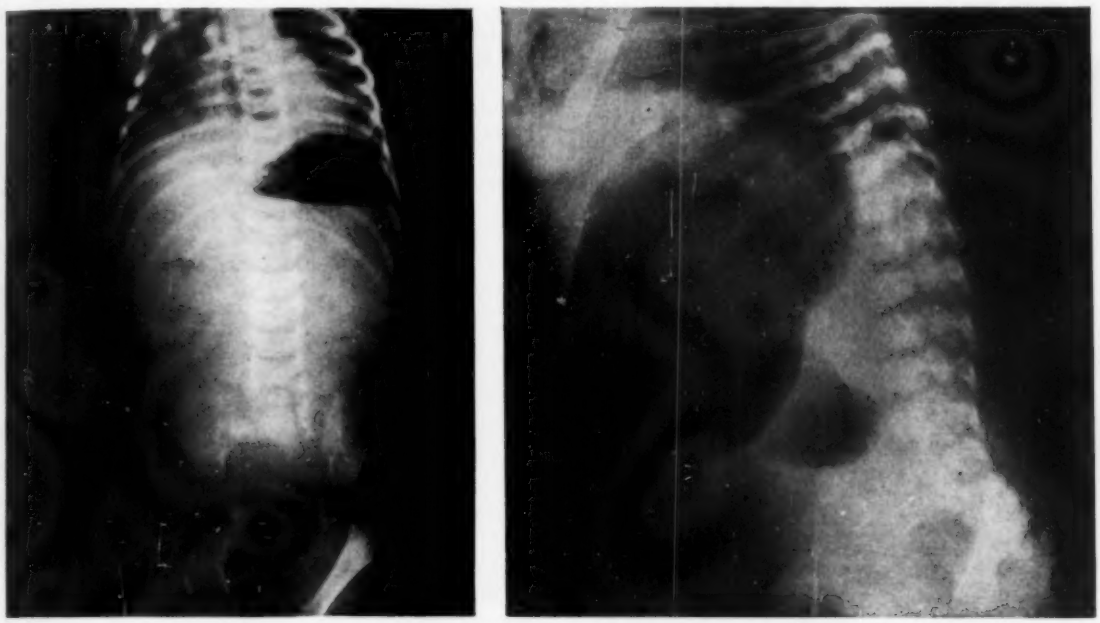
FIG. 442.—*Case* 1. Barium meal of same patient at age of 14 years, showing anastomosis and duodenal pouch.

They are sometimes difficult cases to anæsthetize and there were occasionally some anxious moments during the course of the operations. On the whole they stood the operation remarkably well.

Operation.—In the case of duodenal atresia, I made either a midline or a right rectus-splitting incision. To by-pass the atresia, I did either a posterior gastro-enterostomy or a duodenojejunostomy. While on theoretical grounds it would appear that the duodenojejunostomy would be the ideal operation, in the follow-up of the cases no advantage was seen over the posterior gastro-enterostomy. I used No. 0000 catgut on an atraumatic needle for the anastomosis. It has sometimes been recommended that where a septum is causing the atresia, a satisfactory result may be achieved by perforating the septum with a probe passed through the bowel wall, but my experience has not confirmed this. This method was attempted in *Case* 17 (a case of duodenal atresia) and in *Case* 11 (an atresia of the jejunum), and in both it was shown at the autopsy that the aperture would have been inadequate. It has nothing to recommend it over a satisfactory anastomosis.

Again, in some of these cases the clinical signs and symptoms, together with the radiograph, have suggested an atresia, but on opening the peritoneal cavity the bowel has looked quite normal externally. This was so in *Case* 17. The child was in very poor condition and thought to be a case of duodenal atresia, together with some cerebral damage (caused at birth). The anæsthetist was very reluctant to give a general anæsthetic. However, he yielded to

persuasion. I opened the abdomen and there was no sign of a distended duodenum or collapsed jejunum. To make quite sure, I passed a probe along the interior or duodenum to break down any septum present. There was no resistance to the probe. The baby died thirty-six hours later and the autopsy showed an atresia due to a septum. He also had a cerebral hæmorrhage which was the cause of death.



A B

FIG. 444.—*Case* 23. Flat radiograph showing gas shadows in duodenal atresia. A, Anterior view. B, Lateral view.

Another example was *Case* 23 where the external appearance of the stomach and duodenum did not suggest any obstruction and pressure over the stomach appeared to expand the jejunum. (*Figs.* 444, 445.) No anastomosis was done. However, the symptoms persisted and, after three days, a second radiograph still showed gas only in the stomach and proximal duodenum. I re-opened the abdomen and did a duodenojejunostomy. After this the baby made a straightforward recovery.

Furthermore, in no case of those patients who died and the pathology could be verified at post-mortem, had the diagnosis of atresia been incorrect, so that, where the symptoms and signs, together with the radiographs, point to an atresia, it is safer to do an anastomosis, even if there are no obvious signs of obstruction on inspection of the bowel.

In cases of atresia of the jejunum or ileum the technical difficulties of the operation have been much greater. As the baby is suffering from acute intestinal obstruction the general condition is worse. Efficient decompression of the proximal bowel is often difficult. At the operation there is usually an enormously distended proximal blind end which, owing to the distension, has become devitalized and may be necrotic in parts, or even gangrenous and require resection. The distal end is minute. The only possible anastomosis is a lateral one. The lower bowel may be partially distended by passing down a fine catheter and then injecting saline during the course of the anastomosis and the proximal end may be decompressed by suction. I have only had two successful results with this type of defect. (*Figs.* 446, 447.)

FIG. 445.—Gas shadow after operation.

In atresia of the colon, the best form of surgical intervention still remains controversial. The condition is so rare that even surgeons interested in this type of work are unlikely to get more than one or

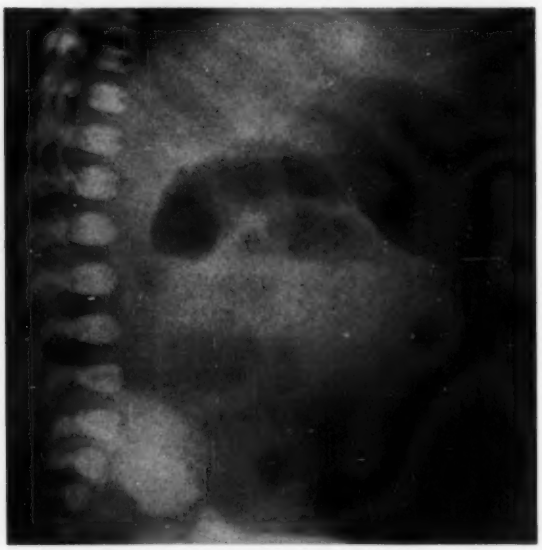


FIG. 446.—Flat radiograph showing fluid levels due to an acute obstruction caused by a volvulus of a loop of small intestine and atresia at age of two days.

two in a surgical lifetime, so that one cannot be dogmatic about the best treatment, and each must be treated *secundum artem*.

In my own case, the baby was greatly distended

FIG. 448.—*Case* 35. Atresia of colon showing proximal distended colon on the right approximated to distal narrow colon on the left, preparatory to the anastomosis. Site of atresia held in the forceps.

on admission to the hospital. At operation the site of the atresia was deep in the pelvis. I did a transverse colostomy first. This decompressed the bowel. Later the colon distal to the atresia was expanded by gentle rectal washouts. The photograph taken just prior to the second operation shows that these methods were successful. (*Fig.* 448.) The diameter of the proximal bowel was reduced by half, while that of the distal bowel was almost doubled. At the second operation a side-to-side anastomosis was effected above and below the atretic portion of colon. All seemed to be going well until eleven days after the operation when the baby developed signs of acute intestinal obstruction. Attempts to overcome this by suction through a duodenal tube

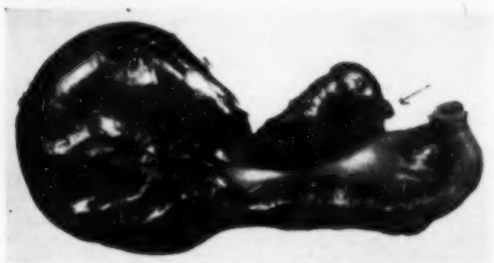


FIG. 447.—Specimen of the loop of gangrenous bowel. Site of atresia indicated by the arrow. (× ⅔.)

were unsuccessful, and a radiograph showed well-marked fluid levels. I re-opened the abdomen and found a length of small bowel adherent to the colostomy. The bowel was very fragile and even the most gentle handling caused peeling of the peritoneal coat. However, the baby's condition appeared so desperate that it was considered advisable just to relieve the obstruction and replace the bowel. He quickly recovered from the operation, but a week later a fæcal fistula appeared and soon nearly all the intestinal contents were escaping by the fistula and digesting the skin. I again re-opened the abdomen, exposed the site of the fistula, which was the result of a portion of the small bowel having necrosed, excised the affected area, and did a lateral anastomosis. Two months later I finally closed the colostomy and the child is now fit and well.

This patient certainly had a stormy passage, and I have the impression that if the distended colon and the adjacent collapsed portion had been brought out to form a left inguinal colostomy at the first operation, and the anastomosis completed by a Paul-Mikulicz operation, some of the complications might have been avoided. Should I get another similar case, I shall probably try that method.

Post-operative Treatment.—The post-operative treatment of these patients requires very careful supervision by a well-staffed pædiatric department. An example of the difficulties which can occur and have to be overcome is illustrated by *Case* 15. After gastro-enterostomy for a duodenal stenosis, the patient had a very difficult convalescence. Large aspirations of gastric contents continued and she required an intravenous drip for twelve days after the operation. The wound became infected with *Staph. aureus*. Penicillin and sulpha drugs were given for six days. A fortnight after the operation she developed otitis media and required bilateral myringotomy. Following this the temperature became normal and all seemed to be going well. However, the ears continued to discharge and a

growth of *B. pyocyaneus* was obtained. She then began getting fits. Suddenly she started to improve and eventually became quite fit and well.

Some of the patients required two or more operations before they made satisfactory progress. *Case* 21 had a duodenojejunostomy at 5 days, but he continued to vomit and a radiograph showed no evidence of any gas having gone beyond the

FIG. 449.—*Case* 21. Flat radiograph showing gas only in stomach and duodenum.

FIG. 450.—*Case* 21. Barium meal by stomach tube, showing complete atresia.

FIG. 451.—Flat radiograph after operation, showing anastomosis not patent.

FIG. 452.—Flat radiograph after abdomen had been re-opened and a Ryle's tube had been guided through the anastomosis. Now shows gas shadows in remainder of bowel.

duodenum and the barium was still present in the duodenum. On the seventh post-operative day I re-opened the abdomen and manipulated the tip of a Ryle's tube, which had been passed down the

FIG. 453.—A photograph taken November, 1953, of 11 of the recorded cases.

œsophagus, into the stomach, through the anastomosis, so that fluid could be injected directly into the intestine and help to expand it. A check radiograph after the operation showed air present in the small bowel. The patient made a speedy recovery and is now alive and well. (*Figs.* 449–452.)

RESULTS

The results of the series are classified in *Table I.*

From this it will be seen that out of 35 cases of congenital intestinal obstruction, 16 survived.

If the cases of multiple lesions, which were hopeless from birth, are excluded, there were 16 recoveries and 12 deaths, giving a recovery rate of 58 per cent. The best results were obtained in cases of stenosis or atresia of the duodenum, where a recovery rate of 70 per cent was obtained.

Two of these recoveries died later. *Case* 10 had a duodenojejunostomy at the sixth day of life for a duodenal atresia from which he made a good recovery. At the age of 2 years he was re-admitted to the Newcastle General Hospital with a diagnosis of melæna. He was treated by blood transfusion. At the age of 4½ years he was admitted to the Royal Victoria Infirmary with a history of hæmatemesis. Examination at that time revealed an enlarged spleen. His B.P. 170/110. He continued to vomit blood. Three weeks after his admission he began to bleed again. He had a torrential hæmatemesis and it was necessary to transfuse him continuously to replace the blood lost. He was then operated upon by a surgeon at that hospital, who did a splenectomy. He died 48 hours later and the post-mortem showed :—

1. Congenital atresia of duodenum.
2. Duodenojejunostomy (surgical).
3. Congenital abnormality of the portal vein.
4. Œsophageal varices (ruptured).
5. Bronchopneumonia.
6. Essential hypertension.

The other unfortunate late death was *Case* 31. He made a good recovery from his operation for volvulus of bowel with a duodenojejunal atresia but he was re-admitted to hospital seven weeks later with jaundice and he died, after three weeks, from hepatitis.

Undoubtedly the experience we have gained from these cases is beginning to bear fruit, both in early diagnosis and treatment. When a pædiatrician has been attached to a maternity unit, very early diagnosis has been obtained. A good illustration of this was *Case* 34. The infant's mother had a considerable degree of hydramnios in the latter part of the pregnancy. In view of this, a careful inspection was made for congenital abnormalities when the baby was born. There were no obvious external defects. He was not fed for the first 24 hours and a flat radiograph showed gas in the stomach only. A second radiograph 24 hours later showed the same result. There had been no bile-stained vomits and meconium had been passed. The baby was transferred from the Bensham Hospital, where he was born, to the Newcastle General Hospital, where further radiographs were taken and a barium meal showed complete obstruction in the third part of the duodenum.

I operated upon the child at 75 hours. The stomach and first and second parts of the duodenum were distended and the jejunum collapsed. A gastro-enterostomy was performed and the child made a satisfactory post-operative recovery and is now alive and well. (*Fig.* 453.)

SUMMARY

A series of 35 cases of congenital intrinsic intestinal obstruction have been reviewed with an account of some of the difficulties of their treatment.

I would like to acknowledge my thanks to numerous House Surgeons and Registrars and to the skilled nursing staff of the pædiatric department of the Newcastle General Hospital who were often responsible for the success in many of these cases.

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ADRENAL CYSTS

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ADRENAL cysts are rare; the number of published cases, including 4 reported here, is about 81. They are probably less rare than this figure suggests, for Wahl (1951) found 9 in a series of 13,996 autopsies—an incidence of 1 in 1555. Most are clinically silent, being found at autopsy or at operation for other diseases, but some cause pain or swelling necessitating operation. They do not produce a characteristic clinical picture; their effects are purely mechanical, and symptoms of endocrine disturbance are absent; for anatomical reasons they are most likely to be mistaken for enlargements of the kidney. Before operation it is sometimes possible to identify the cause of the trouble as a cyst, but its adrenal nature can be determined only at operation or after pathological examination of the specimen.

Several types of adrenal cyst have been described, but the only ones of clinical importance are the lymphatic and the hæmorrhagic. These are not mutually exclusive, for some cysts have features of both and can be typed only according to the predominant feature. Various classifications of adrenal cysts have been made, but they are not of practical importance because the exact nature of an adrenal cyst is often not determinable. The explanation is that when the cyst is examined pathologically, either all clues have been obliterated by pathological changes, or the evidence is consistent with more than one diagnosis. There is no substantial modern review of the literature, but the old ones of M'Cosh (1907), Doran (1908), and de Vecchi (1910) are still of interest.

FIG. 454.—*Case* 1. Adrenal (bottom right) with cyst showing loculi full of pale homogeneous material. (Natural size.)

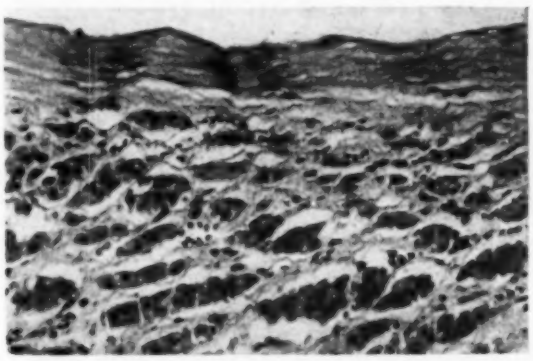

FIG. 455.—*Case* 1. Fibrous wall of cyst resting on adrenal cortex. (× 180.)

FIG. 456.—*Case* 1. Fibrous trabeculæ dividing cyst into loculi. (× 120.)

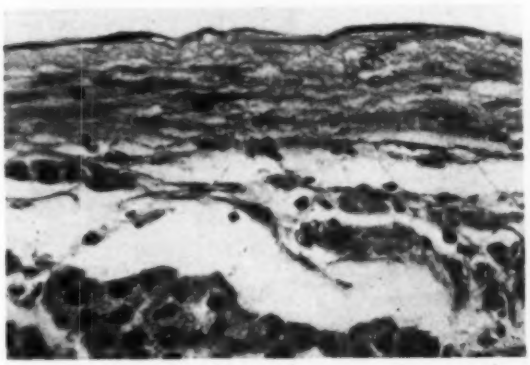

FIG. 457.—*Case* 1. Two long flat nuclei of the endothelium lining the cyst. (× 380.)

CASE REPORTS

Case 1.—*Lymphatic Cyst of Right Adrenal.* A married woman, aged 33, was admitted in March, 1948, to Boundary Park General Hospital, Oldham, under the care of Mr. A. H. Barber. She was nearing the end of her first pregnancy, and had been ill for about a week with influenza. Her response to treatment was poor, and the fœtus was thought to be dead, its death being ascribed to toxæmia from the mother's influenza. The patient was too ill for laparotomy and died two days after the expected date of delivery; death was attributed to toxæmia following protein absorption from the dead fœtus. The obstetrical aspects of the case are discussed by Barber (1949).

AT AUTOPSY.—The significant findings were a left ovarian pregnancy, a cyst of the right adrenal, and tuberculosis of the left adrenal.

The *adrenal cyst* measured 6·5 × 5 × 3 cm. and had a smooth yellowish surface marbled by fine blood-vessels.

When cut open after fixing, it was seen to be multilocular and full of soft, grey, translucent jelly (*Fig.* 454).

HISTOLOGY.—The jelly in the *adrenal cyst* was weakly eosinophil and homogeneous, no echinococcus hooklets being found. No fat was demonstrated in the jelly. The

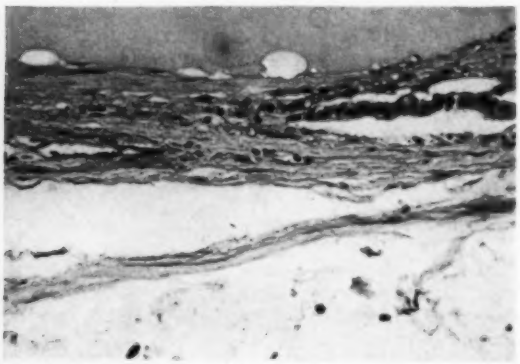

FIG. 458.—*Case* 1. Junction of cyst wall (top of figure) and the fibrous capsule of the adrenal. Right half of figure shows a single layer of cortical cells, the final attenuation of the cortex before the junction. (× 190.)

cyst wall was composed of a thin band of fibrous tissue (*Fig.* 455). Trabeculæ from this (*Fig.* 456) formed the walls of the loculi, which were lined by a single layer of flat endothelial cells (*Fig.* 457). The base of the cyst rested on cortical tissue (*Fig.* 455). For some distance laterally from the base, the cyst wall was separated from

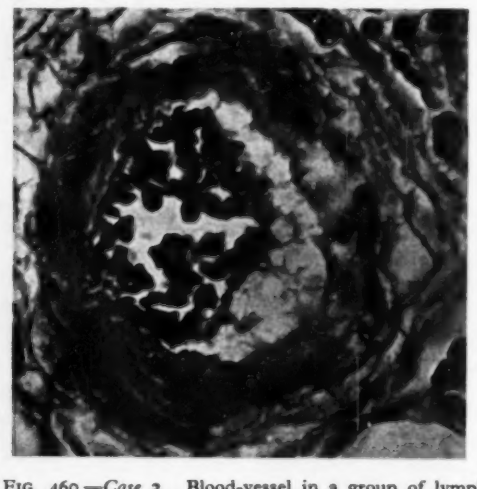

FIG. 460.—*Case* 2. Blood-vessel in a group of lymphocytes in periadrenal fat. Right half of vessel shows pallor (? œdema), which at one point affects the whole thickness of its wall. (× 750.)

the gland capsule by a tongue of cortical tissue that rapidly thinned out to a layer only one cell thick. Beyond a certain point, cyst wall and gland capsule were in contact and barely recognizable as distinct structures (*Fig.* 458). The medulla and the non-cystic part of the cortex were structurally normal, though both showed some lymphocytic infiltration.

The *left adrenal* was largely caseous and showed the typical features of tuberculosis: multinucleated giant cells, endothelioid cells, lymphocytes, and acid-fast bacilli.

Case 2.—*Hæmorrhagic Cyst of Right Adrenal with a similar Cyst of Liver.* A male welder, aged 48, was admitted in June, 1948, to Oldham Royal Infirmary with an eight-months' history of continuous aching in the right hypochondrium. The patient was extremely tender above the tip of the ninth rib at the outer border of the rectus muscle, and on radiography the gall-bladder showed a stippled circular outline suggestive of calcification.

AT OPERATION.—Mr. A. L. Kenyon found the abdomen full of dark altered blood. The right lobe of the liver contained a large, cystic blood-filled tumour. This

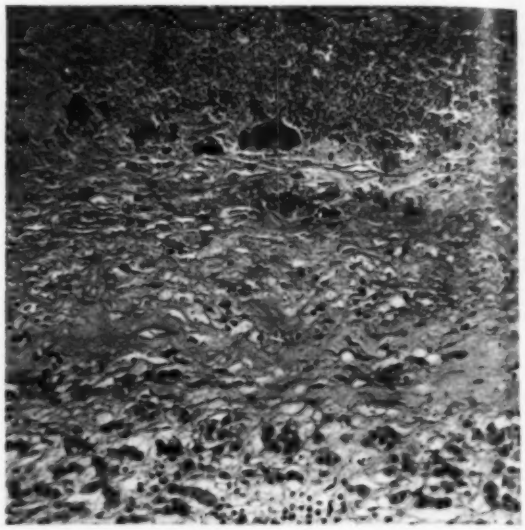

FIG. 459.—*Case* 2. Thick fibrous wall of adrenal cyst separating blood-clot (top of figure) and adrenal cortex. (× 150.)

was excised with the gall-bladder, but the patient died soon after leaving the operating table.

AT AUTOPSY.—The *right adrenal* showed a disk-shaped cyst 6 cm. in diameter lined by ragged blood-clot.

HISTOLOGY.—The *adrenal cyst* had a thick wall of dense fibrous tissue lined by unorganized blood-clot (*Fig.* 459). The cyst wall rested on adrenal cortex.

FIG. 461.—*Case* 2. Blood-vessel in a group of lymphocytes in periadrenal fat. Extreme right of figure shows vessel wall infiltrated with lymphocytes. (× 750.)

Adipose tissue adjoining the cortex showed large collections of leucocytes; these were mainly lymphocytes, but plasma cells and eosinophils were also present. The blood-vessels in these leucocyte collections were not always normal; the walls of some vessels looked œdematous (*Fig.* 460) or were infiltrated with lymphocytes (*Fig.* 461).

The *liver cyst* resembled the adrenal cyst in having a thick wall of dense fibrous tissue, but the blood-clot it contained was partly organized (*Fig.* 462). Many portal tracts contained collections of lymphocytes (*Fig.* 463). No lesions were seen in the blood-vessels of the liver, but the liver-cell columns near the cyst were often widely separated from one another, the appearances suggesting œdema (*Fig.* 464).

The *gall-bladder* showed a thick mass of cellular granulation tissue, like that in the liver cyst, along part of its outer surface; this was the only significant abnormality.

Comment.—The cause of the adrenal cyst is not clear, but it may have been rupture of blood-vessels damaged by inflammation, a possibility in keeping with the vascular lesions near the adrenal. These lesions and the leucocyte collections that accompanied them can be appropriately described as an angiitis, although the appearances were not suggestive of syphilis or periarteritis nodosa. There is no evidence as to the cause of the liver cyst, but this was so like the adrenal cyst that both may well have been due to the same pathological process. The granulation tissue on the gall-bladder could be explained by organization of blood-clot following hæmorrhage from the liver. Clinically, the adrenal cyst, the liver cyst, and the gall-bladder fibrosis may all have caused symptoms, but it is doubtful whether their individual contributions could have been distinguished.

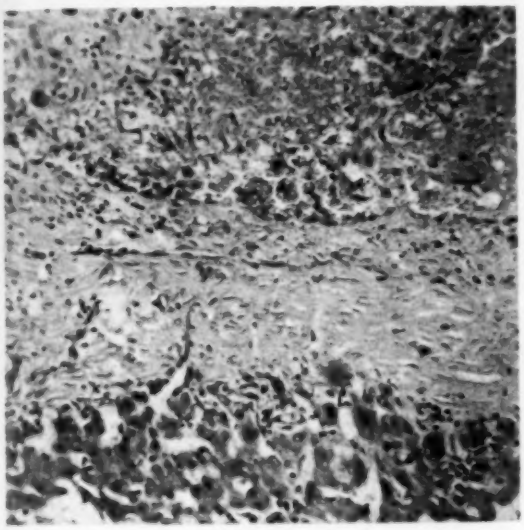

FIG. 462.—*Case* 2. Thick fibrous wall of liver cyst resting on liver tissue (bottom of figure). Upper third of figure shows granulation tissue on extreme left, unorganized blood-clot elsewhere. (× 120.)

Case 3.—*Hæmorrhagic Cyst of Left Adrenal.* A married woman, aged 34, was admitted to Ashton-under-Lyne General Hospital in January, 1953, and came under the care of one of us (R. T. G.). She complained of pain in the left renal area for the past ten weeks. The pain passed down the back and through to the left hypochondrium, and was persistent. It was accentuated by coughing, and there were severe spasms which made the patient roll about and vomit. Other symptoms were anorexia, dyspnœa, nausea, shivering, and frequency of micturition.

ON EXAMINATION.—The patient was pale and obese. There was tenderness in the left renal angle and a large firm mass in the left upper quadrant of the abdomen, extending into the flank, over the midline, and to 8 cm. below the level of the umbilicus. The mass was dull to percussion and not mobile. Her hæmoglobin reading was 47 per cent (7·0 g.) and she was febrile (99–100° F.).

X-ray Examination.—The air-bubble in the gastric fundus was displaced to the right of the midline, and the splenic flexure was pushed downwards (*Fig.* 465). A descending pyelogram showed the right kidney to be normal, but the left kidney was enlarged and displaced downwards by a large, soft-tissue mass which merged with the upper pole. The pelvi-caliceal system was distorted and function poor. An ascending pyelogram (normal bladder) confirmed the distortion and downward displacement of the renal pelvis and showed no communication between the pelvi-caliceal system and the mass (*Fig.* 466). The lesion was thought to be a hypernephroma or a large solitary renal cyst.

AT OPERATION.—The incision was made in the line of the twelfth rib, extending forwards on the abdominal wall. A large tense cyst was seen, and, after evacuation of some three pints of dark blood and old clots from it, was removed with the kidney.

The patient made a normal recovery, remaining well.

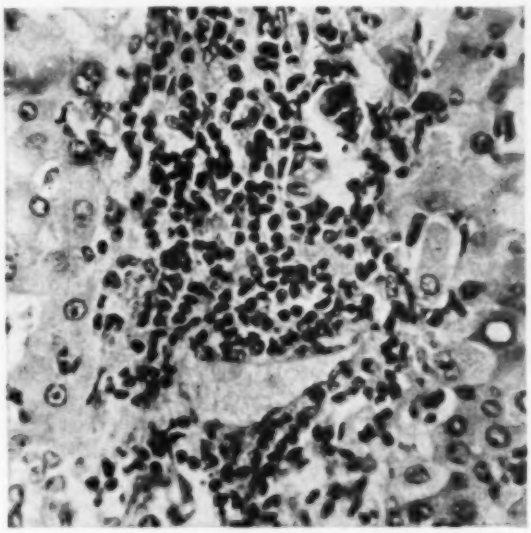

FIG. 463.—*Case* 2. A group of lymphocytes in liver. (× 310.)

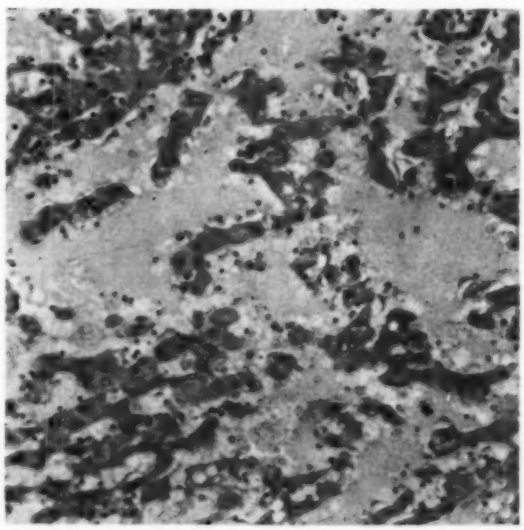

FIG. 464.—*Case* 2. Liver near cyst. The liver-cell columns are widely separated by clear coagulum (? œdema). (× 120.)

THE SPECIMEN.—The cyst was 18 cm. in diameter and had a thick fibrous wall lined by organizing blood-clot. At the upper pole of the cyst there was an ill-defined yellowish area representing the left adrenal. The cyst was lightly adherent to the upper pole of the kidney and was easily separated from it. The kidney itself appeared normal.

HISTOLOGY.—The *adrenal cyst* had a thick wall of fibrous tissue lined by granulation tissue representing organized blood-clot. Internal to this was unorganized clot. The left adrenal was incorporated in the wall of the cyst and flattened (*Fig.* 467), but the cortical tissue

itself appeared normal (*Fig.* 468); part of it may have disappeared following pressure atrophy (*Fig.* 469). No medullary tissue was seen.

The *kidney* showed a small group of lymphocytes, but was otherwise normal.

FIG. 465.—*Case* 3. Plain film showing displacement of gas content of stomach and colon.

FIG. 467.—*Case* 3. Cyst wall incorporating adrenal. From left to right the figure shows: (1) narrow outer part of cyst wall (light grey); (2) narrow adrenal (darker grey, with light vascular spaces along inner edge); (3) broad inner part of cyst wall; and (4) blood-clot (dark grey). (× 7.)

Case 4.—*Hæmangioma of the right adrenal.* A widow, aged 79, was admitted in March, 1952, to Boundary Park Hospital with chronic bronchitis and heart failure, and died within two days.

AT AUTOPSY.—The important findings were chronic bronchitis, advanced purulent bronchopneumonia, hydatid cysts of the liver, and a hæmangioma of the right adrenal.

HISTOLOGY.—The *right adrenal* contained many blood-filled spaces in a dense hyaline stroma (*Fig.* 470). Areas of healthy cortical tissue lay between the vascular spaces. The spaces had walls of fibrous tissue, but it is uncertain whether they were lined by endothelium. The spaces varied widely in size; some were very small (*Fig.* 471), others were large and closely packed, the picture resembling that of a cavernous hæmangioma of the liver (*Fig.* 472).

DISCUSSION

Diagnosis.—Adrenal cysts may be found at any age, though rarely before the age of 30. It is doubtful whether one sex or side is affected

FIG. 466.—*Case* 3. Ascending pyelogram showing displacement and rotation of left kidney.

significantly more often than the other. As a rule only one adrenal is involved; when both are, the lesions are of the same nature and sometimes of the same size. Adrenal cysts may be single or multiple, unilocular or multilocular, and rarely exceed 10 cm. in diameter.

Symptoms are often indefinite—a feeling of weight or distension or a vague ache in the hypochrondrium—but pain is frequent and may be lancinating and suggestive of intercostal neuralgia or pleurodynia. Sometimes there is a sudden onset of severe pain, with nausea, vomiting, and collapse as in acute pancreatitis; this syndrome, which may recur, is probably due to hæmorrhage into the cyst and was doubtless responsible for the fever and anæmia in *Case* 3. When small an adrenal cyst will not be palpable; but as it enlarges, the kidney will be displaced and become more readily detectable. When the cyst is large, bulging of the abdomen and lower ribs may be noticed and a mass in the flank will be apparent. At this stage it is doubtful if the examining hand will be able to differentiate clearly between cyst and kidney; the shape and smoothness of the surface may suggest a cyst, but a thick wall will hide any impression of fluctuation. The possible visceral displacements can be imagined, the important ones being those detectable on radiography, which is the main diagnostic weapon. On the plain film the gas content of stomach or colon may be shifted and give some indication of the size and position of the soft-tissue mass (*Fig.* 465). Calcification in the cyst wall may be revealed; this may occur in an adrenal cyst, but will also indicate the need for Casoni testing to exclude hydatid disease.

Excretion and retrograde pyelography will demonstrate renal displacement and indicate the retroperitoneal situation of the tumour. Renal concentrating power may be little below normal, but pelvis and calices will be rotated or deformed by extrinsic pressure (*Fig.* 466). The lack of communication between pelvicaliceal system and the mass excludes hydronephrosis and pyonephrosis. The bladder is likely to be normal and the urine sterile. The distinction between cystic and physiologically active adrenal tumours should not be difficult; the absence of hypertensive attacks and of changes in the secondary sex characteristics will be apparent on clinical examination and observation.

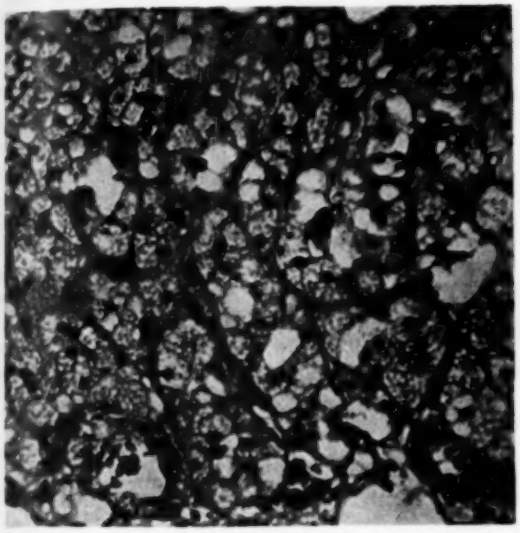

FIG. 468.—*Case* 3. Adrenal cortex in cyst wall. The normal zoning is absent, but the individual cells are healthy. (× 220.)

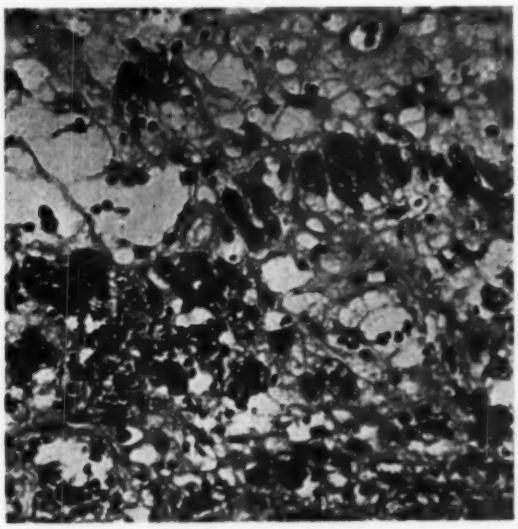

FIG. 469.—*Case* 3. Atrophic part of adrenal. Cortical cells (dark) are individually healthy, but arranged in small groups in fibro-fatty tissue. (× 220.)

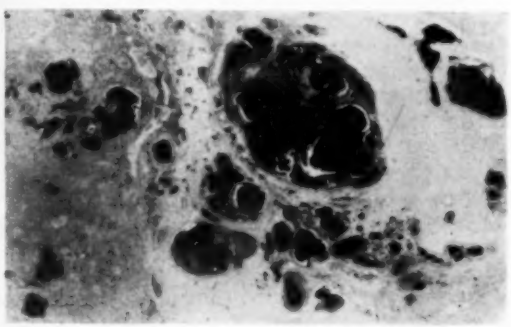

FIG. 470.—*Case* 4. The many dark, rounded areas of various sizes represent blood spaces. (× 5.)

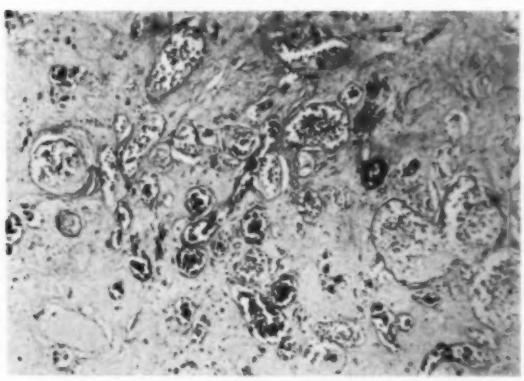

FIG. 471.—*Case* 4. Many small blood spaces in hyaline stroma. (× 65.)

Treatment.—Since malignant disease of kidney, adrenal, or adjacent tissues cannot be excluded with confidence even after full investigation, surgical treatment is indicated if the general condition of the patient will allow. The lumbar approach with resection of the last rib (Sames, 1950) will be employed more often than any other, familiar as it is to both general surgeon and urologist. The peritoneum can be entered towards the front of the incision if it is desired to palpate the opposite adrenal or to aid the dissection. If more space is required, this can be converted into the 'venetian blind' exposure of Nagamatsu (1950). To those who embark on such cases with more radical intentions, an abdominothoracic incision, with resection of the eleventh rib, may appeal (Chute and Soutter, 1949). Full urological investigation will have established that the mass is retroperitoneal and there should be no need for a ventral transperitoneal approach for the purpose of exploration. Whatever approach is used, it appears to be in accord with modern practice so to arrange matters that, if malignant disease is found, ligation of the pedicle can be accomplished without much preliminary handling of the mass. Once a proper plane of cleavage is found, isolation of the cyst should not be difficult or too dangerous. If the cyst is opened and emptied to ease the dissection, the absence of communication between cyst and kidney may be confirmed, and it should be possible to separate and remove the cyst, leaving a good kidney to be slung up in its proper position; examination of the specimen from *Case* 3 illustrates this point. In dealing with large cysts it is wise to have available blood for transfusion in

case of damage to any large vessel. If excision is judged to be too hazardous, marsupialization may be employed, but this is a poor alternative to removal.

Pathology.—The term 'lymphatic cyst' is apt and convenient, but it does not denote any single, well-defined pathological entity. On the contrary, it covers a variety of lesions, probably including

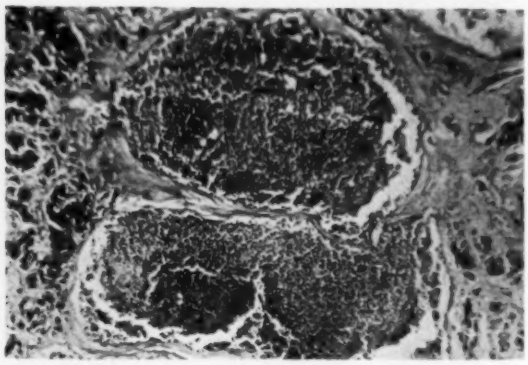

FIG. 472.—*Case* 4. Two large blood spaces with adrenal cortical cells (dark) on left and right. (× 65.)

tumours and malformations of the lymphatics, and dilatations of the lymphatics due to obstruction of the lymph-stream. Most lymphatic cysts are probably lymphangiectases, but these are not clearly distinguishable from lymphangiomas, because the term 'lymphangioma' usually means nothing more than a mass of large spaces full of lymph. Some cysts appropriately described from their general appearance as lymphatic may in reality be hæmangiomas, although there may be no means of proving the fact; it may be impossible to decide whether certain vascular spaces are lymphatics or blood-vessels.

The term 'hæmorrhagic cyst' is also purely descriptive and gives no indication of the aetiology or exact nature of the lesion; it probably covers cysts of widely different origins. Hæmorrhagic cysts could be produced by arteritis, apoplexy, or infarction, or by hæmorrhagic destruction of cysts of other types, including hæmangiomas. Since the hæmorrhage is likely to destroy all evidence as to the nature of the lesion, the term 'hæmorrhagic cyst' is a practical convenience.

Other types of cyst are simply pathological curiosities. An embryonic cyst lined by ciliated epithelium was described by Sick (1903) and a cystic phæochromocytoma by Hedinger (1911). Other possible types include cystic adenomas and echinococcal and tuberculous cysts; the reports of these types are mainly old and leave one in doubt as to the nature of the lesions.

Of our own observations, one of the most interesting is the coexistence of hæmorrhagic cysts in adrenal and liver (*Case* 2). Such associated lesions were occasionally noted by older writers, but the best described example is that of Major and Black (1918). In their case, each adrenal showed a large cystic mass with features of both lymphatic cysts and hæmangiomas; the final diagnosis was lymph cysts, but the authors' rejection of that of hæmangioma was not very confident. In addition, the liver was virtually a hæmangiomatous mass, and two hæmangiomatous areas were found in the skull. Such cases are of great interest because they suggest that adrenal cysts may sometimes be of more than local significance. Possible explanations include: (1) angiitis resulting in hæmorrhagic cysts; and (2) developmental weakness of the vascular system resulting in lymphatic cysts, hæmangiomas, or combinations of these. It may well be a matter of chance whether in a patient with such a disease the adrenals are among the organs affected. Adrenal cysts are thus of interest not only in themselves, but also as possible indicators of more widespread disease.

SUMMARY

Four cases of adrenal cyst are described: (1) a lymphatic cyst of the right adrenal; (2) a hæmorrhagic cyst of the right adrenal with a similar cyst of the liver; (3) a hæmorrhagic cyst of the left adrenal; and (4) a hæmangioma of the right adrenal. In *Case* 3 the cyst was removed at operation; in the others it was found at autopsy.

Adrenal cysts may cause pain or swelling. X-ray examination may show displacement of the gas content of stomach or colon, or calcification in the cyst wall; excretion and retrograde pyelography will show renal displacement and that the mass is retroperitoneal.

These investigations should obviate the need of a ventral transperitoneal approach for the purpose of exploration, and for removal of the cyst most surgeons will use the lumbar approach with resection of the last rib; some may prefer an abdominothoracic incision with resection of the eleventh rib.

If the cyst is first emptied, it should be possible to separate it from the kidney, which could then be slung up in its proper position. Marsupialization is a poor alternative to removal.

The only adrenal cysts of clinical importance are the lymphatic and the hæmorrhagic. The occasional coexistence of cysts in the adrenal and other organs may possibly be due to angiitis or to developmental weakness of the vascular system.

We are grateful to Mr. A. H. Barber, Dr. G. H. H. Benham, and Mr. A. L. Kenyon for allowing us to use their clinical notes; to Professors S. L. Baker and John Morley for reading the manuscript; and to Dr. John Ball for advice on *Case* 2. *Figs.* 455–464 are by the late Mr. F. Ward, *Figs.* 465 and 466 by the Department of Medical Illustration, Manchester Royal Infirmary, and *Figs.* 467–472 by Mr. T. Lawley.

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RODENT ULCER OF THE ANUS

By GEORGE ARMITAGE and IRVINE SMITH, Leeds

The anus is an uncommon site for rodent ulcer. The incidence has been given as once in 150,000 biopsies for malignant disease (Guess, 1935), twice in 3000 anorectal neoplasms during thirteen years at the Mayo Clinic (Buie and Brust, 1933), four times in 237 rodent ulcers reviewed by Wakeley and Childs (1949), and twice in 706 rodent ulcers reviewed by Sutherland (1953). Consequently, in proctological practice the diagnosis is unexpected and may be missed. In 1949 Lott and Alexander could collect records of only 8 cases, publishing some details of these together with a new case of their own.

Four cases have been diagnosed at the General Infirmary at Leeds since 1938 and details of these are recorded.

CASE REPORTS

Case 1.—H. H. (200988), male, aged 59 years, was admitted under the care of one of us (G. A.) on Oct. 30, 1951, complaining that twelve months previously a small

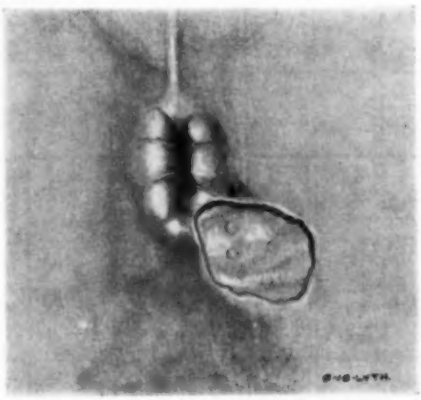

Fig. 473.—*Case* 1. Before biopsy.

abscess at the anus had discharged for ten days. An ulcer had persisted and grown in size so that it now admitted the tip of his little finger. Examination showed a healthy well-built man. Extending from the anal margin in the left posterolateral direction, was a roughly circular lesion 2 cm. in diameter (*Fig.* 473). The centre consisted of smooth shiny scar tissue, well healed except for two to three tiny purulent patches. The outline was irregular and the margin raised, thickened, ragged, and in places undermined. Digital and proctoscopic examination of the rectum were otherwise normal and no enlargement of inguinal nodes was felt. Tuberculosis was suspected clinically, but a biopsy from the margin on Nov. 2, 1951, showed a typical rodent ulcer (*Fig.* 474). On Nov. 6, the lesion was excised under general anæsthesia. The wound healed well and six-monthly examinations since then have so far shown no evidence of recurrence.

Case 2.—Mrs. M. M. (28834), aged 60, attended on Aug. 12, 1948. For six months she had had a lump at the anus and this had 'burst' ten weeks previously. Examination showed a 'malignant ulcer' 2·5 × 2·5 cm. extending to the right from the anal margin. There was some local leucoplakia. Inguinal lymph-nodes were not enlarged. Biopsy showed a basal-celled carcinoma (*Fig.* 475). From Sept. 7 until Sept. 15 radium needles (4 × 1·8 mg. + 2 × 1·2 mg.) gave a dose of 5000 r, and on Nov. 30 the slightly thickened scar was excised by

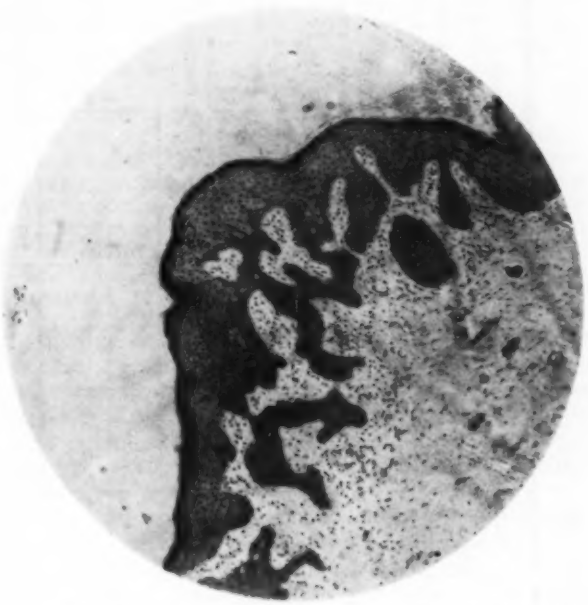

Fig. 474.—*Case* 1. Histology. (H. and E.) (× 100.)

Fig. 475.—*Case* 2. Histology. (H. and E.) (× 100.)

Mr. Gordon Bailey. Although occasional thickening in the anal scar was suspect, later biopsies were always negative. The patient died on Dec. 24, 1952, from carcinoma of the breast with metastases.

Table I.—Available Details of 23 Cases of Rodent Ulcer of the Anus

Case No.	Author	Reviewed by Lott and Alexander	Sex and Age	Symptoms	Length of History	Signs	Size of Ulcer (cm.)	Neoplasm suspected before Biopsy	Histologist reported Rodent Ulcer	Treatment		Follow-up
										Radiotherapy	Surgery	
1	Pennington, 1923		M. 53	Itching		Fissure with hard edges			+	+		
2	Guess, 1935	+	M. 52	Protrusion at anus	8 mth.	Ulcer at anal margin	2		+	140 mg.-hr. radon seeds	Local excision	Death 5 yr. later (coronary thrombosis). No recurrence of ulcer
3	Tucker and Helwig, 1938	+	M. 43	Pain and blood	1 yr.	Enlarged anal papilla resembling a small tumour			+	3500 r 185 kV. +600 mg.-hr. (applicator)	Local excision	Well. No recurrence 9 mth.
4	Gabriel, 1941	+	M. 70	Ulcer at anus	2 yr.	Flat ulcer, no induration	2		+		Diathermy excision	Well. No recurrence 12 mth.
5	Harvey, 1946		? ?	?	?	Growth encircling anus		–	+	4650 mg.-hr.		Well. No recurrence 8 yr.
6	Gabriel, 1948		F. 63	Blister at anus	3 yr.	Flat papule with raised edges 2 cm. from anal margin	1		+		Diathermy excision	Well. No recurrence 3 yr.
7	Lott and Alexander, 1949	+	F. 62	Itching	?	Palpable thickening in anal canal	2	+	+	550 mg.-hr.	Local excision	Well. No recurrence 8 mth.
8	Wakeley and Childs, 1949		M. 62	Chronic ulcer	4 yr.	Irregular ulcer with hard edge	1·2	–	+		Local excision	
9	Wakeley and Childs, 1949		M. 64	Pimple at anus	Some years	Ulcer	1		+		Local excision	
10	Wakeley and Childs, 1949		M. 56	Lump at anus	5 yr.	Irregular ulcer at anal margin	0·5		+		Local excision	
11	Wakeley and Childs, 1949		M. 69	Ulcer at anus	5 yr.	Irregular ulcer at anal margin with hard edge	1	+	+		Local excision	
12	Bacon, 1950		? ?	?	?	Ragged irregular ulcer with raised edge			+			
13	Bacon, 1950		? ?	?	?	Ragged irregular ulcer with raised edge			+			
14	Armitage and Smith, 1954		M. 59	Sore place	1 yr.	Chronic ulcer with hard edges at anal margin	2		+		Local excision	Well. No recurrence 3 yr.
15	Armitage and Smith, 1954		F. 60	Piles	6 mth.	Malignant ulcer at anal margin	2·5 × 2·5	–	+	Needles. 5000 r in 8 days	Later excision	Well. No recurrence 4 yr. Death 4 yr. later. Ca. Breast.
16	Armitage and Smith, 1954		M. 64	Nil		Ulcer at anal margin	2·5 × 2		+	Needles. 6000 r in 9 days	Excision	Well. No recurrence 3 yr.
17	Rosser, 1931	+	Details not given						+			

Table I.—Available Details of 23 Cases of Rodent Ulcer of the Anus—*continued.*

Table I.—AVAILABLE DETAILS OF 23 CASES OF RODENT ULCER OF THE ANUS—*continued.*

Case No.	Author	Reviewed by Lott and Alexander	Sex and Age	Symptoms	Length of History	Signs	Size of Ulcer (cm.)	Neoplasm suspected before Biopsy	Histologist reported Rodent Ulcer	Treatment		Follow-up
										Radiotherapy	Surgery	
18	Buie and Brust, 1933	+	Details not obtained						+			
19	Buie and Brust, 1933	+	Details not obtained						+			
20	Roux-Berger and Ennuyer, 1948		Details not given						+	+		
21	Lawrence, 1941	+	F. 73	Growth at anus. Blood and slime p.r.	1 yr.	Annular fungating growth surrounding and stenosing anus	7–10	+	+		Abdomino-perineal excision of rectum	Died in 3 wk. No P.M.
22	Lawrence, 1941	+	M. 68	Diarrhœa and blood	7 mth.	Annular fungating growth surrounding and stenosing anus	6 × 5	+	+		Perineal excision of rectum	Died in 33 mth. No P.M.
23	Armitage and Smith, 1954		F. 69	Ulcer. Blood and slime p.r.	3 yr.	Growth involving whole anus	7–10	+	+	Needles. 6500 r in 6 days	Colostomy 5 mth. later	Died in 6 yr. Metastases from carcinoma of rectum

Case 3.—Mr. A. S., aged 64, was being cystoscoped by Mr. L. N. Pyrah on Feb. 23, 1951. An ulcer was seen at the anal margin. It measured 2·5 × 2 cm. and did not involve the anal canal and had caused no symptoms. A biopsy was taken and reported as showing a basal-celled carcinoma. After retropubic prostatectomy on June 18, the ulcer was treated by radium implant (6250 r in 220 hr.). At the last examination in July, 1954, there was no sign of recurrence.

Case 4.—Miss H. D., aged 69, attended on Aug. 12, 1938, complaining of an ulcer at the anus for the past three years, with the passage of a blood-stained discharge per rectum for six months. Examination showed an obese woman with "a growth surrounding the whole anal margin". A biopsy of this was reported as showing a basal-celled carcinoma. From Aug. 15 to Aug. 21 this area received 6500 r from radium needles (8 × 3 mg.+ 3 × 1·8 mg.). Discharge from the anus continued and the ulcer did not heal. On Dec. 1 a left iliac colostomy was constructed. On Oct. 13, 1939, the anus was healed, but a large mass was palpable higher in the rectum. The patient died on Dec. 2, 1944, with extensive metastases and a carcinoma of the rectum. Autopsy was not permitted.

In *Table I* are set out, where available, details of Lott and Alexander's 9 cases, the 4 cases from Leeds, and 10 other cases found in the literature, bringing the total to 23. Of these, 4 are set aside because of insufficient detail and 3 because clinical progress suggests other rectal disease (in spite of a histological diagnosis of rodent ulcer).

Two of them (Nos. 21 and 22) had "large fungating growths" for which the rectum was excised, one dying in three weeks and one in thirty-three months, each without autopsy. The other (No. 23) had a "growth encircling the anus" treated by radiotherapy, but needed a colostomy four months later and died six years later with known carcinoma of the rectum with widespread metastases.

From a consideration of the remaining 16 cases, the following facts seem worthy of note:—

Age and Sex.—The ages range from 43 to 70 with an average age of 59 years. There were 9 males, 3 females, and 4 with no note of sex.

Symptoms.—An 'ulcer' or 'sore place' was the commonest complaint (7 cases). Others complained of a 'lump' or piles (3 cases), and itching (2 cases); these symptoms had been present for periods varying from six months to five years. One patient was unaware of his condition, which was noticed during cystoscopy.

Signs.—A definite ulcer was noted in 11 cases (69 per cent), usually at or just touching the anal margin, with an irregular outline and hard or slightly raised edges and usually measuring about 1 × 2 cm. A much larger lesion at the anus is very unlikely to be a rodent ulcer. In 11 cases (69 per cent) new growth was *not* suspected until reported by the pathologist. This emphasizes once more the value of taking routine biopsies from this region.

Treatment.—Just as for rodent ulcer in other sites, there seems little to choose between radiotherapy and simple excision. Frequently both methods of treatment have been used together, probably because the correct diagnosis was not manifest until after excision, which was then considered

to have been inadequate and therefore supplemented by radiotherapy.

Prognosis.—Few good follow-up details are available in the literature; what there are suggest that the prognosis is good.

SUMMARY

1. Four cases of rodent ulcer at the anus are recorded.

2. Twenty-three cases have been collected and 16 of these are reviewed.

3. The lesion occurs in old people.

4. Without routine biopsy the diagnosis may be missed.

5. An anal lesion exceeding 3 cm. diameter is unlikely to be a rodent ulcer.

6. Surgery and radiotherapy both offer a good prognosis.

We should like to thank Mr. L. N. Pyrah, Mr. A. A. D. La Touche, and Mr. Gordon Bailey for allowing us to publish details of their cases; Mr. G. V. G. Lyth for his coloured illustration, and Mr. W. Blackledge, of the Leeds University Photographic Department, for photomicrographs.

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TRACHEAL STENOSIS

REPORT ON ONE CASE OF RELIEF AND RECONSTRUCTION

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AND J. WATT

FULL-TIME ANÆSTHETIST TO THE AUCKLAND HOSPITAL BOARD

THE relief of obstructions due to disease and injury of the main air-passages is sufficiently uncommon and the surgery so uncertain, that the report of a successful issue in an unusual case may be of some surgical interest, especially as it follows work already published in this journal (Rob and Bateman, 1949).

Our patient, a young woman gravely ill with tuberculous stenosis of the trachea, was relieved by a pedicle autograft from her own left bronchus which was made to provide a ciliated inlay across the stenosis. Arising from this preliminary report, such a graft, provided by a segmental bronchus, might be employed more generally to relieve bronchial stenosis. The following principles have been elaborated to deal with special problems in tracheobronchial surgery:—

1. The maintenance of closed-circuit anæsthesia for adequate oxygenation of the blood throughout the whole period so that operation can proceed with deliberation. It is necessary to advance the intratracheal tube into the bronchial system beyond the stricture. In the case reported this was not difficult and oxygenation was maintained in this curarized patient using the Magill tube (without inflating the cuff) and standard anæsthetic technique.

2. The reconstructed airway must be sutured to make an airtight closure and prevent leakage into the mediastinum until the tissue planes are sealed by inflammatory reaction. The graft must also be supported to maintain the reconstructed lumen and prevent flutter when normal breathing is resumed.

3. The reconstruction must not act as a barrier to the free natural lift of mucous secretions into the pharynx. In this connexion a complete lining of ciliated epithelium is greatly to be preferred to a non-ciliated lining, especially in cases with peripheral disease of the lung in which retention of sputum is a possibility.

4. The airway must be permanently maintained and not subject to late contractures. The pedicle autograft is designed to provide a complete ciliated and supported graft to replace tracheal tissue lost by disease or injury.

CASE HISTORY

M. R., female, aged 28 years, developed pulmonary tuberculosis in 1944. A right artificial pneumothorax was induced in 1945 for infiltration in the upper and middle lobes. Severe deterioration occurred in 1948, with the development of a left upper-lobe cavity 2 in. in diameter. A left upper 7-rib thoracoplasty was performed and sputum converted. The right artificial pneumothorax was abandoned, in 1949. In 1952 she developed a wheeze and 'asthma'. Bronchoscopy in January, 1953, disclosed narrowing of the trachea to the size of a lead pencil, with active tuberculous granulation tissue 1½ in. above the carina. She was treated for six weeks with

streptomycin and isoniazid and the sputum became negative. Although there was considerable stridor she was discharged home only to be re-admitted as an emergency in May, 1953, with partial asphyxia. This was relieved by medical means. Bronchoscopy and bronchograms in January, 1953 (Dr. C. McDowell) confirmed the presence of a stenosis of the trachea 1½ in. above the carina measuring approximately 1 cm. in diameter. At this stage the stenosis could be by-passed with a small calibre bronchoscope to show the right bronchial tree to be normal and no gross disease of the left. Bronchoscopy and bronchograms in May, 1953, showed considerable increase in narrowing of the trachea at the region previously demonstrated, and almost complete stenosis of the left bronchus 1 in. from the carina (*Fig.* 476). There was some distension of the right bronchial tree consistent with increasing stenosis of the trachea.

CLINICAL STATE.—She spent all her time and thoughts in maintaining breathing and little else. Any excitement would induce coughing and, with it, a sense of asphyxia. She was emaciated and cyanosed. With forced expiration she had a harsh vibratory stridor heard all over the ward.

TREATMENT.—Early surgical relief was imperative and it was thought that a vascular pedicle graft, using the healthy segment of the left main bronchus with its ciliary lining, would provide an inlay repair for the tracheal defect exposed following longitudinal incision of the stenosed segment; Dermis grafts (Gebauer, 1950) had not been entirely satisfactory for this purpose, especially in open tuberculous cases. The operation was practised first in the post-mortem room and then in the surgical laboratory, to allow surgical and anæsthetic details to be worked out.

OPERATION.—On July 29, 1953, the chest was opened through the original left thoracoplasty incision, under general anæsthesia administered by Dr. J. Watt. The regenerated ribs were incised right up to the root of the neck to expose the whole intrathoracic course of the trachea. The left lung was freed and excised, leaving a long bronchial stump. The sutures used for bronchial closure were left long so that they could be passed under the arch of the aorta and used to withdraw the bronchus above this. The mediastinal pleura overlying the trachea was incised and and the stenosis localized 1½ in. above the aorta. The intratracheal tube could be felt just above this. The aorta was mobilized by dividing the upper two intercostal vessels on both sides, and the bronchus withdrawn above the aorta behind the recurrent laryngeal nerve. The bronchus was now incised posteriorly along its entire length, and the incision was extended right up the trachea and across for ½ in. beyond the stricture. The intratracheal tube was now advanced down into the right bronchus and inflation of the lung maintained. Everting mattress sutures, placed in position before coaptation, were now drawn up to anchor the vascular bronchial flap as an inlay into the trachea.

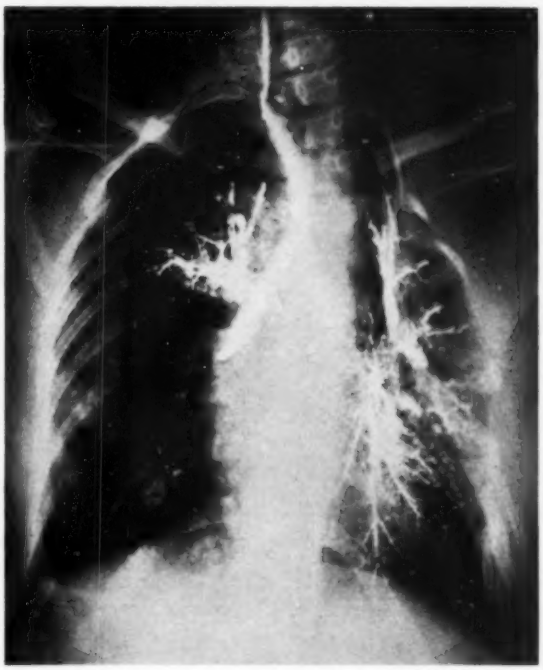

FIG. 476.—Pre-operative bronchogram.

Interrupted silk sutures, inserted all around the periphery of the graft, ensured that there would be no air leak. The mediastinal pleura was sutured over this repair and the chest closed with underwater drainage, allowing a negative pressure to expand the graft. Post-operative bronchoscopy showed a left recurrent laryngeal palsy, a crescent-shaped trachea in the region of the graft, and some flutter in the grafted area, but the bronchoscope could be passed down to the carina and the lumen was maintained on withdrawal of this support.

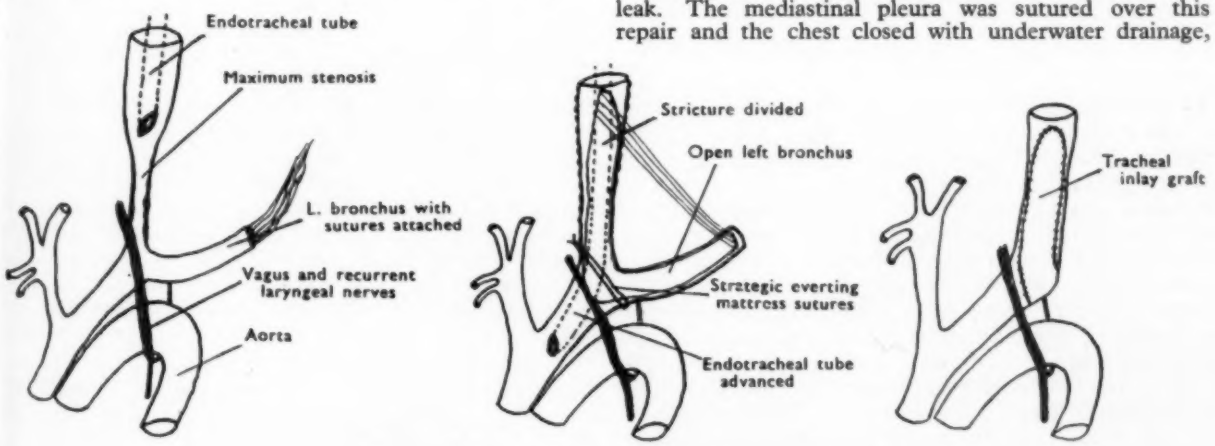

FIG. 477.—Details of lesion and operative procedure.

Details of the lesion and operation procedure are sketched in *Fig.* 477. During the first 48 hours the patient was nursed in an oxygen tent. Intermittent suction was used to clear the trachea. She quickly gained strength and lost all secretions. Further convalescence was uneventful. Three months after the operation she had a normal airway and had gained a stone in weight. She

has a normal voice ; is in good health, good spirits, without cough, and exceedingly pleased with her relief. Post-operative radiographs are appended (*Fig.* 478).

DISCUSSION AND HISTORICAL SURVEY

The work of Taffel (1940) on dogs showed that small windows cut in the trachea and patched securely with fascia lata would maintain the airway and become

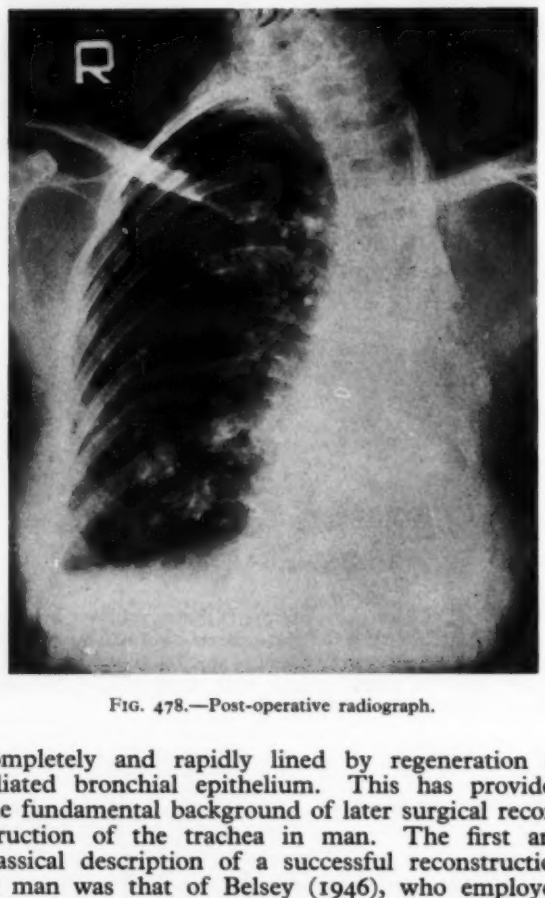

FIG. 478.—Post-operative radiograph.

completely and rapidly lined by regeneration of ciliated bronchial epithelium. This has provided the fundamental background of later surgical reconstruction of the trachea in man. The first and classical description of a successful reconstruction in man was that of Belsey (1946), who employed a cylinder of fascia lata supported and splinted by stainless steel wire to provide an airway and allow regeneration of bronchial mucosa, following surgical removal of a recurrent bronchial adenoma of the thoracic trachea. Daniel (1948), repeating Taffel's work, demonstrated experimentally that glass and metal prostheses could be used to provide a satisfactory airway and allow regeneration of bronchial mucosa. Removal of the splint, however, was followed by collapse of the regenerated epithelium unsupported by cartilagenous rings. The method used by Belsey, with modifications, has provided the standard surgical means of relief.

Rob and Bateman (1949) reconstructed the cervical trachea using tantalum gauze to support the fascia lata. Gebauer (1950 a, b), reported 11 cases in which he employed dermis homografts, supported by stainless steel wire to relieve bronchial and tracheal stenosis of tuberculous origin. In 4 cases of tracheal stenosis there was a mortality of 75 per cent. This method was, however, successful in 3 cases reported by Donald Paulson in 1951, (Gebauer, 1952). There was complete restoration of the bronchial mucosa with only slight narrowing at the graft site. One operation was for injury, one for recurrent carcinoma, and one for tuberculous stenosis of the trachea just below the glottis. This last patient died later from exacerbation of peripheral disease and is pertinent to our presentation.

Thomas Edgerton (1952) reports success in reconstruction of complete segments of the trachea and laryngopharynx, using tantalum mesh support covered by a complete split skin-graft instead of fascia. It would seem more applicable to cases with a healthy bronchial tree in which cilia have a less necessary role.

Carter and Strieder (1950), working in the animal laboratory, showed normal healing of free autogenous cartilage grafts without degeneration of cartilage and without stenosis at the line of suture provided this was everted. Homografts were uniformly unsuccessful owing to degeneration of the cartilage and subsequent stenosis of the lumen.

The method described in this paper fulfils requirements for any reconstruction of the thoracic trachea in the near neighbourhood of the carina where resection (and end-to-end anastomosis) or repair by a patch inlay are not applicable. It provides a lining of healthy ciliated mucosa to the trachea and is therefore particularly suitable for tuberculous cases with some secretions and a low vital capacity. It is simply an extension of the technique for standard bronchial closure except that the edges are everted to provide a smooth unobstructed lumen. It needs no special technique and can be carried out with standard anæsthetic apparatus and an intratracheal tube long enough to advance into the appropriate main bronchus, beyond the stricture. It entails the loss of a lung, but this is a price worth paying in exchange for progressive stenosis and asphyxia, especially if the sacrificed lung is itself diseased.

The same principles may be applied to the repair of any healed stenosis, and modifications can be worked out for lesions of the main bronchi, using the segmental bronchi to enlarge the main stem.

Appreciation is expressed to Dr. Chisholm McDowell for careful reading of the manuscript; Mr. Berge, Clinical photographer to Green Lane Hospital, for the photography; Miss Blechynden for the illustrations.

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THE PERITONEUM

A PLEA FOR A CHANGE IN ATTITUDE TOWARDS THIS MEMBRANE

By D. C. WILLIAMS, CARMARTHEN

THE rapid increase in surgical enterprise and greater endeavour towards the eradication of abdominal lesions which at one time were considered completely inoperable, have created a position in which peritonization must sometimes be omitted. It is widely held that this practice produces adhesions. The view that peritonization is of vital importance as a means of preventing adhesions on raw surfaces must be challenged. The likelihood of firm adhesions forming in the presence of raw areas was emphasized by Grieg Smith (1895). Berman (1950) in his text made explicit the view generally held to-day: "When a raw surface has been made, it should be covered, just as in the skin, to avoid dense scars. Lacking peritoneum, we may use the omentum as a pedicle or free graft. If this is not available, tabs of mesenteric fat, appendices epiploicæ, the broad ligaments, or other available mesothelial-covered structures" should be utilized—which reveals the analogy underlying his precept. The wisdom of early epithelial apposition has been repeatedly confirmed since Pasteur and Lister made it possible. The problem presented by mesothelial surfaces is an entirely different one from that presented by epithelial surfaces. Scattered through the literature there is quite an appreciable body of evidence which warrants a feeling of doubt as to the desirability of peritonization. Some of this evidence is based upon experiment, some upon clinical observation. Corbett (1917), as a result of careful experimental work, expressed doubt as to the significance of pure uninfected trauma in the aetiology of adhesions. Babcock (1932) expressed the opinion that after radical resections in the pelvis the post-operative progress of his patients was improved by the omission of peritonization. In relation to the question of covering oozing surfaces with peritoneum, Corbett (1917) made some significant observations: "In our experiments when sterile blood or even blood-clots were allowed to remain in the abdomen, marked adhesions did not follow. However, hæmatomata in the mesentery of the bowel almost invariably were followed by dense adhesions."

The later work of Robbins, Brunschwig, and Foote (1949) gives strong support to the view that peritonization is unnecessary: "Not only have anterior and posterior parietal areas been left denuded, but in over forty-five instances of complete excision of the pelvic viscera the entire pelvis was stripped of its peritoneal covering, the small bowel permitted to descend into the pelvis and come into contact with the musculo-fascial and osseous surfaces of the parieties, and there have been no instances of post-operative obstruction due to adhesions."

Experimental work on dogs, performed by these authors, support their clinical observations and tend to show that deperitonization is not the main factor in the causation of adhesions. The experimental work of Thomas and Rhoads, performed on rats and guinea-pigs in 1950, showed that the peritonization of a denuded area on the gut more than doubled the number of adhesions. Singleton, Rowe, and Moore (1952), carrying out work in America parallel with my own, reported a series of experiments on dogs which showed that "the likelihood of adhesion formation was increased if raw areas were reperitonealized by suturing, grafted with autogenous peritoneum or covered by plication, than if allowed to heal spontaneously".

I submit the proposition that the omentum or other structures will not become adherent to an inflamed tissue unless it is itself involved in the inflammatory process. I believe this concept to be important, because, as will be shown later, it explains why a raw area, as such, does not incite adhesion formation.

The most frequent adhesion observed by the surgeon in its early stages of formation is that between the omentum and the acutely inflamed appendix, gall-bladder, or perforated ulcer. Menkin (1940) repeatedly emphasized the rapidity of formation of the fibrin barrier. Milnes Walker (1949) pointed out that, in the peritoneal cavity, a protective layer of fibrin forms in a surprisingly short time—in a matter of hours. It is, therefore, in the emergency operation that one gets more information on this matter. In such operations close observation will show that any structure involved in an early adhesion is invariably inflamed, as shown by one or more of the signs—hyperæmia, œdema, exudation of fluid on the surface, and loss of lustre. In the case of a little girl operated upon a few hours after the onset of her first attack of appendicitis, omentum was found loosely adherent. Even at this early stage biopsy of the adherent portion showed histological evidence of inflammatory reaction. In the intestine it is even more apparent that both structures adhering to each other are always inflamed. I contend that the normal structures only become adherent to the diseased one if the normal one becomes involved in the inflammatory reaction.

This is illustrated by a patient operated upon in July, 1947, for acute appendicitis with localized peritonitis. Omentum was not visible, but the infection was kept within limits by coils of inflamed small intestine. Her abdomen was again opened in 1952 for strangulation of a loop of ileum by a band. The attachment near the cæcum was continuous with the other short adhesions, and the appearances suggested that the other attachment was to a part of ileum which formed one of the coils found which were inflamed and which limited infection at the original operation (*Fig.* 479). No other adhesions were present. It seems to me that the omentum is the structure which most commonly adheres to an inflamed surface because when it comes into contact with such a surface it remains there long enough to become involved in the inflammatory reaction. In view of my clinical observations, I present the following speculation for consideration.

In a raw area, the actual cellular damage is so slight, and the products of it, such as leukotaxine, are so diluted by peritoneal fluid, that if the area is left exposed no harm results. If, however, one peritonizes the area, the irritants are kept in the locality, and, therefore, the advantage of the exclusion of the area by a thin membrane is more than offset by the increased concentration of these substances. This

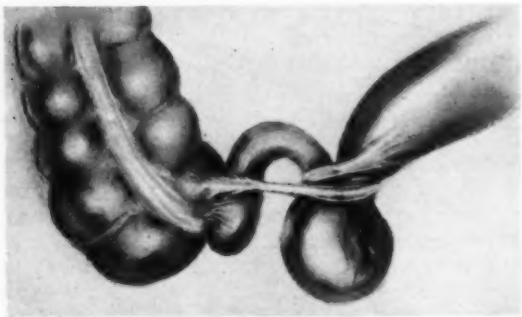

FIG. 479.—Appearance of adhesions five years after appendicectomy.

is clearly shown by the conduct of blood-clot. If retroperitoneal and therefore localized, it produces adhesions; if free in the peritoneal cavity, as after a ruptured ectopic gestation, it does not do so.

Looking at the opened abdomen, as the surgeon sees it, nothing could appear more obvious than that the principle of epithelial apposition should apply also to the peritoneum. The problem here is, however, a completely different one from that relating to an area denuded of epithelium. Epithelialization is a slow process—0·5 mm. per day. The peritoneum is not an epithelial surface, it is not highly specialized, its diverse potentialities depend upon its primitiveness.

The rather rough manipulation that may need to be carried out in order to peritonize an area awkwardly placed may do far more harm than any good that is intended, apart from the introduction of suture material, which, though often necessary, is offensive to the tissues. An obstruction sometimes results from a knuckle of gut passing through a small defect in the suture line. This is an ever-present danger in a difficult peritonization. Hertzler (1919) wrote: "In the days of through-and-through suture, which allowed the edges of the peritoneum to retract and thus become exposed to the abdominal contents, adhesions were almost universal."

The truth of this statement does not necessarily imply that the adhesions were due to non-peritonization of the abdominal incision. I wonder whether the adhesions found in those cases were due to some other cause such as mild infection.

Greig Smith (1895) argued that because such firm adhesions result when a serous surface is in apposition to a raw area, therefore, when a firm adhesion is required, peritoneum should be sutured to a raw area. As a result of this argument, he advocated trial of a method of anastomosis, whereby epithelium was apposed to epithelium and peritoneum to a raw area. He was not violating any fundamental principle. If his premises were correct, his argument which was quite logical should lead to a sound operative procedure. Clinical experience has shown, however, and I think conclusively, that the Lembert procedure is the correct one. Therefore, I submit that Greig Smith's premises that a serous surface will regularly adhere to a raw surface, though widely accepted then and now, do not represent the true facts.

It would seem to me that deperitonization has practically no bearing at all on the question of adhesions, apart from the fact that where there is a raw area it marks the site of devitalized tissue consequent upon the manipulations which were necessary for eradication of the disease. It will be the part most liable to receive, accidentally, a deposit of glove powder or, purposely, any bacteriostatic powder that happens to appeal to the surgeon at the time. Moreover, it will also be the region most likely to be infected. These appear to me to amount to be adequate cause for the production of adhesions, without implicating the raw area as such. There appears to be no definite evidence to suggest that the raw area is, in itself, the cause of adhesions.

CLINICAL OBSERVATIONS

No one gives any thought to the peritoneum in Ramstedt's operation, but it is eminently successful. Since 1942 I have ceased to peritonize the gall-bladder bed. In 1952 I had occasion to open the abdomen of a married woman, aged 48, upon whom I had performed cholecystectomy without peritonization four years previously. No adhesions were found.

In 1945 I performed two Wertheim's hysterectomies leaving extensive areas denuded of peritoneum. Neither patient has given cause for anxiety. During the past six years I have left large deperitonized surfaces in five other cases involving hysterectomy without cause for regret. I have never peritonized after any variety of partial colectomy and have not had cause to regret this omission.

Normally I peritonize after excision of the rectum. Occasionally I omit this step. This does not appear to jeopardize the patient's satisfactory progress. In 1953 I found no evil effect from leaving an area including almost the whole pelvis and one-third of the anterior abdominal wall denuded of peritoneum. In radical excision of the rectum with conservation of the sphincter, I routinely omit peritonization. Whenever I have seen a band causing trouble it has rarely been at a site which is even consistent with the denuded area view. When sectioned it has usually shown evidence of a foreign body or there has been a history of infection. Often denuded areas are blamed for catastrophies, which a little thought would show to be due to other causes. From clinical observations it would appear to be safe to assume that peritonization has not been proved to be a necessary procedure.

EXPERIMENTAL OBSERVATIONS

Observations on rabbits were made on the regeneration of areas denuded of peritoneum, on the formation of a peritoneal surface over a pseudo-appendix stump formed by the ligation of a bowel perforation, and on ligated omentum which has had part of its peritoneal surface removed.

Regeneration on a Denuded Area.—In 11 rabbits a portion of parietal peritoneum was removed

from the anterior abdominal wall distant from the incision. Two days later, one rabbit was peritoneoscoped, the denuded area was found to be smooth but not glistening. There were no adhesions, but this mode of examination was not considered as good as laparotomy and, therefore, not used again. Two rabbits were examined three days after operation. In one there was a flimsy adhesion to the midline incision, but otherwise there were no adhesions, the raw area being smooth but not glistening. Histologically the denuded area was

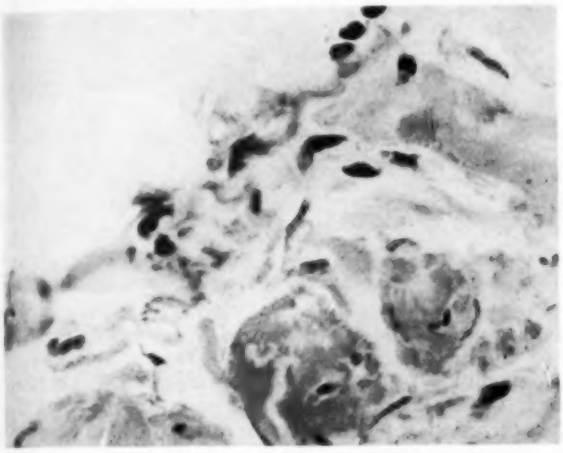

FIG. 480.—Denuded area after three days. (× 585.)

covered with fibrin with entangled cells scattered here and there at random. The cells appeared to be derived from the connective tissue deep to the raw area. There was no uniform layer of cells on the surface (*Fig.* 480). The appearances were similar throughout the area.

Two rabbits were examined five days after denudation of peritoneum. The raw areas were smooth and glistening. There were no adhesions. Histologically the number of cells in the fibrinous layer had increased greatly. That the origin of these cells is from the deeper tissues is more obvious at this interval of time. There is a multiple layer of cells on the surface completely covering it (*Fig.* 481).

Seven days after operation, 6 rabbits were examined. Four had no adhesions, the raw areas being smooth and glistening. Histologically the surface cells were beginning to show signs of becoming differentiated into a single layer to form a mesothelial surface (*Fig.* 482).

In all cases the appearances were uniform throughout the area, both macroscopically and microscopically. The process of repair takes place simultaneously and rapidly over the whole area. This is due to the fact that the cells arise from the subjacent tissues and they arrive at their final position by migration and not by growth as a continuous sheet as is the case with epithelial repair.

In one of the rabbits examined there was an adhesion along the abdominal wall incision, which was slightly infected, and this adhesion spread in one part as far as that part of the denuded area nearest the incision. The remainder of the denuded area was smooth and glistening. In the remaining rabbit the denuded area was smooth and glistening. The skin wound markedly infected did not quite overlie that in the peritoneum. An adhesion was present opposite this infected part of the skin. Both these latter rabbits died within the following week. A mass of adhesions were present obviously due to accidental spread of infection during the examination.

Behaviour of Ligated Stumps (Pseudo-appendix).—The bowel was perforated and ligated in 10 rabbits, leaving a stump similar to a non-crushed appendix stump. In each case it was

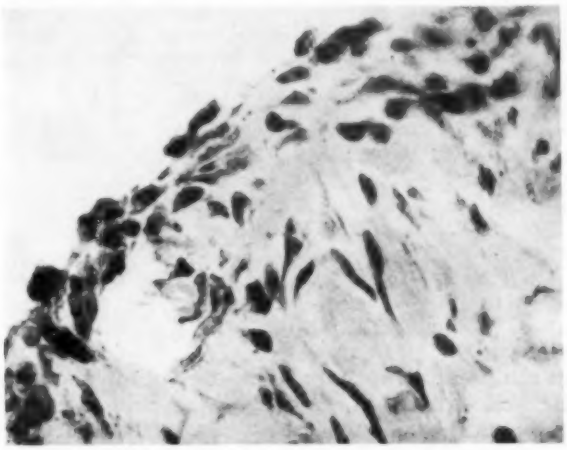

FIG. 481.—Denuded area after five days. (× 585.)

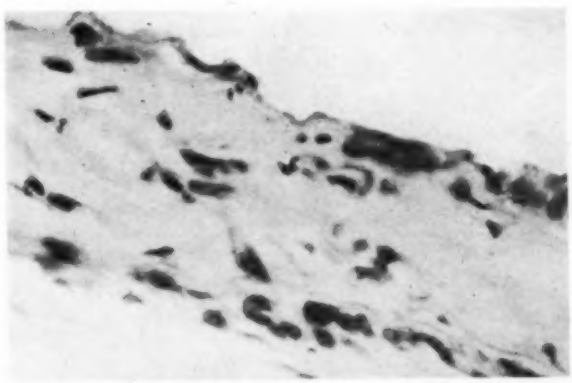

FIG. 482.—Denuded area after seven days. (× 585.)

carbolized with pure phenol and dropped back into the peritoneal cavity.

A week later examination of 10 rabbits showed no adhesions in 7 cases. In 1 rabbit the stump was difficult to detect as its appearance was little different from the remainder of the bowel wall. The stump in this case was smaller than could be used with safety in human surgery. In 6 rabbits the perforated areas were pale yellow, smooth, and glistening. Histological examination showed cells scattered at random in the fibrinous layer and a single layer of mesothelial cells was becoming differentiated on the surface. These cells were larger than those found in the regeneration of a denuded area (*Fig.* 483) and their source not so readily determined.

They may have come mainly from the periphery, but, if so, they apparently migrated as they were discrete and had not grown as a single continuous

sheet. More deeply the stump contained vegetable fibres and there was a marked leucocytic infiltration. No organisms were found in the Gram-stained section. In one rabbit the laparotomy incision was infected and a loop of gut was adherent at this site,

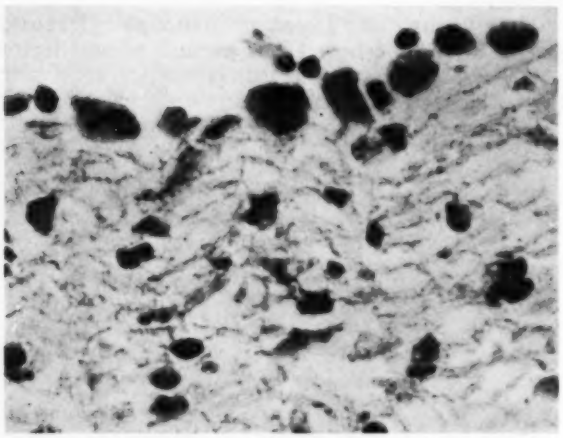

FIG. 483.—Re-formation of mesothelial surface over pseudo-appendix stump. (× 585.)

but the pseudo-appendix stump free of infection was pale yellow, smooth, and glistening, and free from adhesions. One rabbit showed a swelling deep in the abdominal wall, although the skin had healed

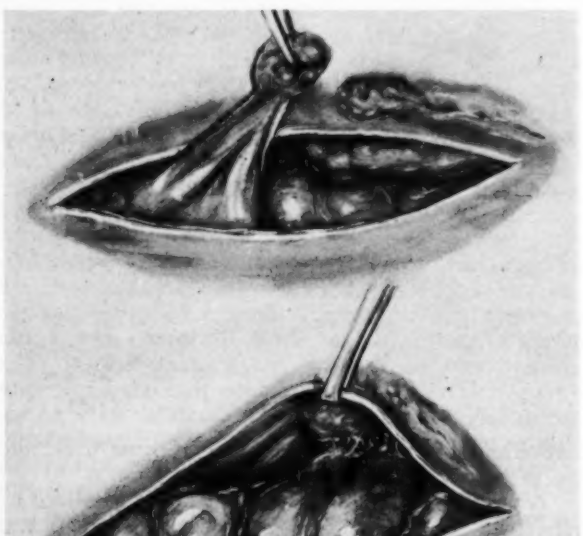

FIG. 485.—A, Omental stump smooth and glistening parietal incision inflamed; B, Eversion of parietes to show adhesion of gut to parietes at the site of infection.

perfectly well. On opening the abdomen, this proved to be an abscess which was closed on its deep surface by adherent gut. The bowel at the perforation was adherent to another part of the parietes and here again it was evidently due to infection. The most probable explanation seems to be that infection was conveyed from perforation to the incision at the time of operation and that phenolization was inadequate. One rabbit had an adhesion between the bowel at the site of perforation and the parietes distant from the incision. The abdominal incision in this instance had healed very well. The toilet of

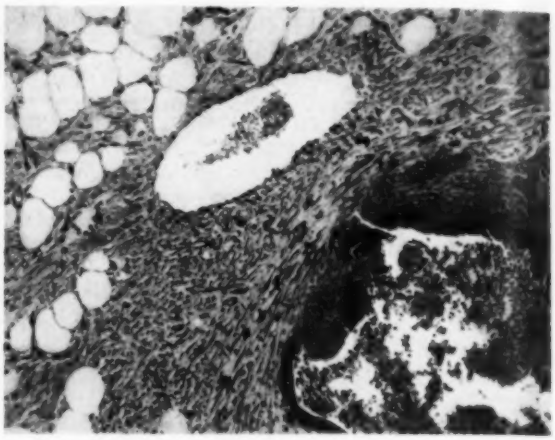

FIG. 484.—Omental adhesion to stump. (× 72.)

the pseudo-appendix stump had been carefully carried out, but histological examination showed that phenolization of the stump had not completely destroyed the mucosa. Vegetable fibres were present and considerable leucocytic infiltration was evident. The remaining rabbit exhibited an adhesion of omentum to the pseudo-appendix stump. A loop inserted at the junction of stump and omentum showed no organisms on culture. Histological

FIG. 486.—Adhesion of omentum to intraperitoneal silk knot and free end.

examination showed inflammatory reaction in adherent omentum as well as stump (*Fig.* 484).

Mucosal debris, vegetable fibre, and leucocytic infiltration were evident in the stump. Organisms were present in the stump, though not in the junctional tissue between omentum and stump. In these experiments the smallest stump healed the most rapidly of the series. Larger stumps containing vegetable debris did not contract adhesions unless infection was present.

Behaviour of Ligated Stumps (Omentum).—A piece of omentum about 4 cm. long was ligated in 8 rabbits and the distal 2 cm. removed in 7 of them. A stump was thus left with a complete peritoneum

covering in 1 rabbit and with a surface partly denuded of peritoneum in the other 7 rabbits. Examination of these rabbits seven days later showed that there were no adhesions involving the ligated omentum and the surface was smooth and glistening. In 2 cases the laparotomy wound was slightly infected,

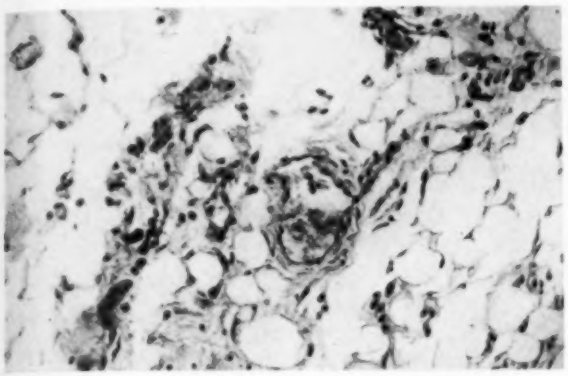

FIG. 487.—Omentum adherent to silk. (× 135.)

and in 1 of these gut was adherent at the site of the infection and showed obvious signs of inflammation (*Fig.* 485).

Histologically the stump with a complete peritoneal surface was practically unchanged, though its blood-supply had been cut off for a week. The raw surfaces of a ligated stump showed no fibrin layer and no evidence of regeneration of peritoneum after seven days.

In one instance the omentum contracted an adhesion to a silk knot (*Fig.* 486), although knots and free ends were left exposed intraperitoneally thirty times.

Careful Gram-stained sections revealed staphylococci. Histologically the omentum showed evidence of inflammatory reaction (*Fig.* 487).

SUMMARY AND CONCLUSIONS

Evidence is given in support of the view that a raw area in itself will not cause adhesion formation. The concept that primarily inflamed tissue must produce inflammatory changes in any contiguous structure before an adhesion can form, receives histological confirmation. It explains why infection is by far the commonest cause of adhesion and why a raw area does not incite adhesion formation.

Peritonization, as any other operative procedure, will tend to cause adhesions in proportion as the manipulations are extensive and difficult and the conditions of operating deviate from that of complete asepsis.

The experimental work was made possible by the kindness of Professor J. Gough.

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NON-PARASITIC CYSTS OF THE LIVER

By H. HASHEMIAN AND T. G. I. JAMES

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NON-PARASITIC cysts of the liver are comparatively rare. Davis (1937), in a complete review of the literature, found 499 cases in all: of these, 226 were cases in which operation had been performed; the remaining 273 were found at autopsy. Of the total, 187 were solitary unilocular cysts, 20 were solitary multilocular cysts, while in 241 the cysts were multiple. In the remaining 51, the number of cysts was not stated. An investigation of the case reports since Davis's publication has revealed considerable discrepancy in the type of cyst found, and in some it is impossible to classify the nature of the cyst. For this reason no attempt has been made to bring up to date the total number of cases recorded. On account of the rarity of the condition and the interesting clinical features, the following two cases are reported.

CASE REPORTS

Case 1.—A woman, aged 40, was admitted in August, 1952, with a history of four weeks' continuous upper abdominal pain, most marked in the right hypochondrium. The pain was never severe and was not associated with vomiting. A gradually increasing, slightly tender, swelling in the right hypochondrium had been noticed by her for the same period.

ON EXAMINATION.—She was afebrile, and her general condition was excellent. A large, tender, smooth, cystic swelling occupied the whole of the right hypochondrium. It moved with respiration and its dullness to percussion was continuous with that of the liver. The kidneys were not palpable, and no abnormality was discovered in any other system. A diagnosis of mucocele of the gall-bladder was made and, as laparotomy was indicated, no other investigations were carried out.

AT OPERATION.—The abdomen was opened through a right upper paramedian incision. A large lobulated

and apparently multilocular cystic swelling was found involving the anterior and antero-inferior part of the right lobe of the liver (*Fig.* 488). There was no evidence of cystic disease of any other abdominal organ. A needle inserted into the cyst cavity yielded about a pint of thin dirty yellow fluid. The cyst wall was thick and was incised between stay sutures; the cavity, much to our surprise, was found to be unilocular. The lobulated appearance of the external aspect was caused by bands of thinned-out hepatic tissue running on the surface of the cyst. The gall-bladder did not communicate with the cyst, but was intimately applied to its wall. No abnormality was found in any of the large bile-ducts. As a large part of the cyst was intrahepatic, excision was considered inadvisable. A piece of the wall was excised for histology, and the remainder was marsupialized to the skin, the cyst cavity being drained by a small tube. Examination of the fluid from the cyst showed the presence of cholesterol crystals and Küpfer cells. No hooklets were present, and no organisms were found on culture.

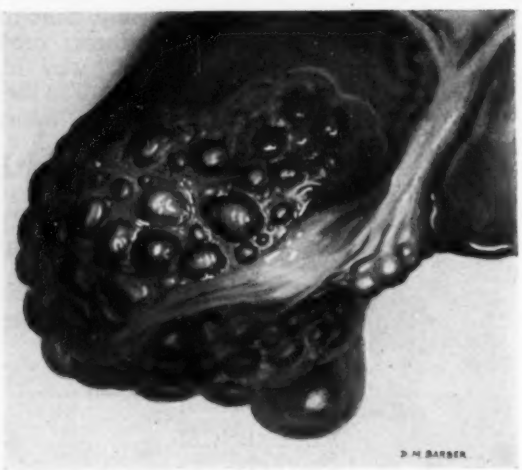

Fig. 488.—Solitary unilocular non-parasitic cyst of the right lobe of the liver. The lobulated appearance was caused by bands of thinned out hepatic tissue running on the surface of the liver.

FIG. 490.—Multiple non-parasitic cysts involving both lobes of the liver.

Post-operative progress was uneventful. Injection of the sinus with viskiosol did not show any communication between the cyst wall and any of the bile-ducts. Drainage through the tube of clear bile-stained fluid continued for about three weeks, when it gradually diminished, the patient being discharged home six weeks after operation with the wound almost healed.

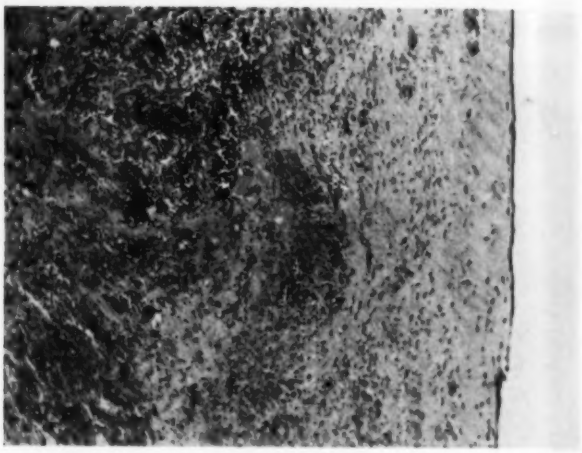

FIG. 489.—Histology of cyst wall showing epithelial lining, fibrous tissue and small bile-ducts at periphery. (× 80.)

HISTOLOGICAL EXAMINATION (*Fig.* 489) of the cyst wall showed it to be lined by a single layer of cuboidal epithelium. Deep to this there was much hæmorrhagic fibrous tissue and a layer of fibrous tissue containing many bile-ducts.

Case 2.—A female, aged 63, was admitted in December, 1951, complaining of abdominal distension and loss of weight of three months' duration.

ON EXAMINATION.—There was a smooth tender mass occupying the whole of the epigastrium, which did not appear to move on respiration. Barium meal examination was negative, and other relevant investigations were normal. A provisional diagnosis of pancreatic cyst was made and laparotomy performed.

AT OPERATION.—The abdomen was opened through a right paramedian incision. Both lobes of the liver were found to be studded with multiple cysts of varying size (*Fig.* 490). No cysts were found in the kidneys, pancreas, spleen, or any other abdominal organ. Clear fluid was aspirated from one of the small cysts and a portion of the wall was removed for histology. The abdomen was closed without drainage. Examination of the fluid showed a protein content of 175 mg. per 100 ml., and a few red cells. No scolices or hooklets were found, and the fluid was sterile.

HISTOLOGY OF THE CYST WALL showed a lining of low cuboidal regular epithelium. The outer part of the wall contained a considerable number of small bile canaliculi (*Fig.* 491).

DISCUSSION

Pathology.—A number of classifications of non-parasitic cysts of the liver have been suggested, but that of Sonntag (1913) appears to be the one generally accepted. He classified them as follows:—

1. Blood and degeneration cysts.
2. Dermoid cysts.
3. Lymphatic cysts.
4. Endothelial cysts.
5. Cysts due to bile-duct obstruction.
6. Cystadenomata.

Most authors differentiate between the simple solitary cysts and the multilocular cysts, and also between the latter condition confined to the liver and polycystic disease. Little is known for certain about the aetiology of either condition, and whether a solitary cyst of the liver is a localized manifestation of polycystic disease or an entirely unrelated process

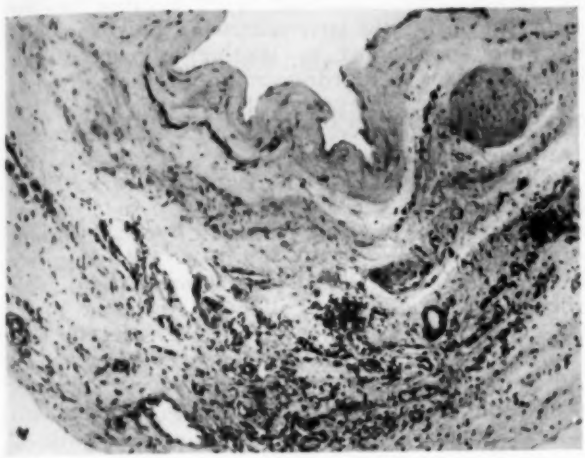

FIG. 491.—Histology of cyst wall showing lining epithelium and small bile-ducts. (× 80.)

remains to be solved. Moschowitz (1906) suggested that the cysts now under consideration arose from aberrant bile-ducts and were associated with congenital anomalies in other parts of the body, especially cysts of the kidney. It is well known, however, that they may occur without any evidence of other defects. If they develop from aberrant bile-ducts it is not at all clear how the cystic structure is produced. Certainly the contents of the cysts may be neither bile nor mucus.

The cysts, whether single or multiple, are more common in children than in adults, and in the former case there may be other congenital malformations such as hare-lip, cleft palate, or spina bifida. Solitary cysts are more commonly found in females in a proportion of 4 to 1. The right lobe of the liver is more often involved than the left, and the antero-inferior portion of the right lobe is the site of election, but the quadrate lobe, or even the round ligament, may be the site of the cyst. They vary considerably in size from a cherry to a coco-nut, or even larger, and they may be wholly or partially intrahepatic, but some become pedunculated. In the majority of cases there is no definite line of cleavage between the cyst wall and the normal liver tissue.

Microscopy of the cyst wall shows it to be composed of connective tissue lined on the inside by a single layer of flat or cuboidal epithelium. There are three distinct zones in the fibrous tissue wall—an inner layer rich in cellular elements, a circularly arranged dense connective-tissue layer poor in cell nuclei with few blood-vessels, and a loose outer layer with elastic fibres, many blood-vessels, and bile-ducts. Many of the latter are compressed, but some may show dilatation, and among them degenerated cells may be seen.

Diagnosis.—The clinical picture is characteristically vague, and variable, and for this reason a pre-operative diagnosis is seldom made. The cysts grow slowly and the majority produce their symptoms only when complications occur, or when they become large enough to press on adjacent organs, e.g., the bile-ducts or the gut. McCaugham and Rassieur (1943), in an analysis of 80 cases, found that an abdominal swelling was the commonest complaint; pain in the upper abdomen was next in frequency, followed by nausea and vomiting, jaundice, dyspepsia, and a sense of pressure in the right upper quadrant. Physical examination usually reveals a cystic tumour in the upper quadrant of the right abdomen, but the majority of cases are diagnosed as mucocele of the gall-bladder, hydronephrosis, mesenteric cyst, hydatid cyst or an ovarian tumour. A barium meal or enema may be helpful in diagnosis; intrahepatic masses displace the colon downwards, whereas lesions of retroperitoneal origin tend to displace it forwards. In cases with complications such as hæmorrhage, suppuration, or torsion when the cyst is pedunculated, the onset of symptoms may be sudden and severe and require urgent treatment.

Treatment.—It is generally agreed that surgery is the treatment of choice in all cysts large enough to cause symptoms. The ideal treatment is excision of the entire cyst, but in many cases, even in the best hands, this is an impossible task. It is a relatively easy matter when the cyst is pedunculated, but attempts at enucleation of a large deep-seated cyst may prove a very formidable business on account of excessive hæmorrhage. If the cyst cannot be excised or enucleated safely, it is best treated by aspiration and marsupialization of the wall to skin or peritoneum with drainage of the cavity. Marsupialization is the only rational treatment in the presence of infection. Other methods of treatment which have been successfully tried are partial excision of the cyst and drainage (Davis), or even anastomosis of the cyst wall to the small intestine (Davis). In cases where marsupialization has been performed, a sinus usually persists for several weeks, but a few cases have been reported where the sinus continued to discharge for some months, or even years. Sclerosing solutions have been used to hasten the closure of the cavity following marsupialization, but they are of doubtful value, because many of these sinuses close spontaneously within a few weeks, while those persisting are often unaffected by sclerosing agents. Pure bile has been known to discharge through the sinus and this is attributed to the rupture of some smaller intrahepatic bile-ducts into the cavity of the cyst. This was seen in our first case, when for some days the drainage consisted of pure bile, while the injection of the cavity with lipiodol showed no evidence of communication with larger biliary tracts.

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SPLENIC ARTERIAL ANEURYSM

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Cases of splenic aneurysm are usually recorded because of their dramatic and frequently fatal intraperitoneal hæmorrhage. There are relatively few published cases of unruptured aneurysm which have been submitted to surgical treatment. Two examples are recorded here of aneurysms discovered incidentally at operation, one treated by excision and the other left in situ. The subject has been fully described in many publications, of which the salient features bear mention.

Incidence.—From the academic standpoint it is important to note that in many instances, some of which have been included in collected series of aneurysms, the precise structure has not been defined (Gillam, 1942); the aneurysm has been false (Anderson and Gray, 1929); or the site of hæmorrhage has been acknowledged as a defect in the arterial wall especially at a point of branching (Smith, 1911; Macleod and Maurice, 1940; Gillam, 1948; and Ogden, 1948). These facts must be borne in mind when considering the incidence of splenic arterial aneurysm under which title the various conditions have been grouped from the practical aspect of their manifestations.

The latest collected series of 198 definite cases exhaustively surveyed by Owens and Coffey (1953) contains some early examples but does not include 12 designated cases, the reports of which lacked definition, and 21 cases quoted in autopsy surveys. These authors state that the over-all total of reported cases is 237. Eight more (Tagart, 1952; Gillam's second case, 1948; Ogden, 1948; the three cases of Zummo, Williams, and Uzanski 1952; and the two described here) may be added, giving a total of 245 recorded cases of splenic arterial aneurysm.

Owens and Coffey (1953) have drawn attention to the striking sex incidence. While all aneurysms, regardless of site, are more common in the male in the ratio of 5 to 1, 67 per cent of their series of splenic aneurysm occurred in females.

Pathology.—In their comprehensive review Sherlock and Learmonth (1942) found atheromatous degeneration in 46 per cent of their cases; the site of atheromatous involvement was the main artery in 51·3 per cent of 76 cases, and the average diameter in 81 examples was 3·4 cm. Aneurysms of larger size have been described. Atherosclerosis thus appears to be the most frequent cause of aneurysm. Owens and Coffey (1953) record this feature in 60 per cent of 159 cases and comment on the frequent localization of arteriosclerosis solely to the splenic artery. Attention has been drawn by many writers to such factors as endocarditis and embolism, loss of elastic tissue (Schuster, 1937), degeneration and necrosis of the media (Anderson and Gray, 1929), the combination of degeneration and defects in the elastic lamina and muscle (Carmichael, 1950), the tortuosity and occasional multiple dilatations of the splenic artery (Sherlock and Learmonth, 1942), the association with aneurysms at other sites, and portal hypertension (Owens and Coffey, 1953). Many of the reports are concerned with rupture of the aneurysm during the later months of pregnancy and following such effort as laughing (Macleod and Maurice, 1940). Rupture occurs into the peritoneal cavity in most cases, but hæmorrhage into the stomach, other viscera, and the retroperitoneal tissues has been recorded.

Clinical Aspects.—The symptoms which have been described are extremely variable. Before rupture there may be pain in the left hypochondrium, sometimes with nausea or vomiting. A tumour may be evident (Davis, 1925; Goullioud, 1928) with palpable or audible pulsation (Brockman, 1930; Mallet-Guy, 1931). The appearance has been that of mesenteric cyst (Tonge, 1948; Palmer, 1950) and operation may have been undertaken on account of splenomegaly, which was present in 45 per cent of 161 cases of the series of Owens and Coffey (1953). Radiological evidence may be an area of calcification (Lindboe, 1932) and visible pulsation (Seids and Hauser, 1941). The outline has been defined by aortography (Owens and Coffey, 1953).

The clinical features of rupture are those of an acute abdominal crisis manifest by internal hæmorrhage. The 'two-stage' rupture has been described by several authors, of whom Owens and Coffey record the incidence of "double rupture" in 21 per cent of 204 cases, the second hæmorrhage developing usually within 48 hours of the primary incident. Fatal rupture of a second aneurysm has occurred 22 months after a successful operation for the first (Parsons, 1936).

Treatment.—The procedures employed in all the surviving cases reported to the present date are given in *Table I*, together with their corresponding mortality figures. Sherlock and Learmonth (1942) suggest that the treatment of choice is splenectomy with removal of the affected segment of the artery. Where rupture has occurred and the site is suspect, the initial approach should be to the splenic artery through the gastrocolic omentum with the object of ligation of the artery near its origin. This procedure was adequate in the case reported by Coffey and Blumberg (1951). Subsequent steps are determined by the condition of the patient and the availability of means of resuscitation. Tagart (1952), who expresses doubts regarding the necessity for routine splenectomy, excised the aneurysm and the spleen. Palmer (1950) removed the aneurysm, which had ruptured during operation, and left the spleen intact.

Where rupture has not occurred treatment may be planned more deliberately and the adequacy of the vasa brevia is the more readily determined. Where splenomegaly is present, as in 18 of 43 cases reviewed by Baumgartner and Thomas (1924), the spleen should be excised. Tanturi, Swigert, and Canepa (1950), who carried out experiments on dogs, gave ample proof of the value of penicillin as a means of

prevention of necrosis of the liver after ligation of the hepatic artery. While the analogy is not exact, it appears wise to follow the same policy in those cases where ligation only has been employed or where the aneurysm has been excised and the spleen left in situ.

Prognosis.—Aneurysms unsuspected during life are encountered not infrequently at post-mortem examinations. Sherlock and Learmonth (1942), in their review of autopsy reports, found the incidence of splenic aneurysm to be 0·039 per cent. It is idle to speculate on the number of aneurysms which escape recognition. Accuracy of prognosis is limited to this extent.

Owens and Coffey record a mortality-rate of 46 per cent for their entire series, including asymptomatic cases. Ninety-four (76 per cent) of 124 cases with relevant symptoms died as a result of the aneurysm. Forty-nine cases submitted to operation for aneurysm showed a mortality-rate of 39 per cent. The addition of 15 cases, all fatal, in which surgical approach was not directed to the aneurysm, raises the mortality-rate to 51 per cent. The list compiled by these authors has been modified to show the cases surviving various operative procedures (*Table I*). Two further reports from the literature, Gillam (1948) and Tagart (1952), and case 1 described below have been added. Despite the absence of a definite sac, the first is included on the basis of its close resemblance to the same author's previous case (1942) which has been included in other collected series. The mortality-rates for the complete series are indicated. The differentiation between the procedures splenectomy alone and splenectomy with excision is not entirely significant as many of the cases present aneurysms of the terminal branches of the artery and splenectomy in these cases necessitates ligation of the vessels proximal to the aneurysm.

Table I.—Records of 33 Cases surviving Operation for Splenic Aneurysm
(*Modified from Owens and Coffey*)

Author	Year	Age	Sex	Splenectomy			Excision of Aneurysm	Ligation of Splenic Artery
				Alone	With Ligation	With Excision		
Winkler	1905	25	F.	1				
Mulley	1918	28	F.			1		
Marshall (T)*	1922	38	F.					1
Hartnett (T)	1922	35	M.			1		
Davis	1925	67	M.				1	
Naher	1926	54	F.			1		
Goullioud	1928	59	F.					1
Brockman	1930	69	F.	1				
Texier and others	1930	40	F.			1		
Lower and Farrell	1931	16	M.				1	
Lindboe	1932	52	F.			1		
Donati	1933	32	M.					1
Haffner	1936	51	F.			1		
Rudnev	1936	45	F.			1		
Tabanelli	1938	32	F.		1			
Fretheim	1938	25	F.	1				
Matronala	1940	26	F.				1	
Sperling	1940	39	F.			1		
Macleod and Maurice	1940	22	F.	1				
Seids and Hauser	1941	59	F.					1
Sherlock and Learmonth	1942	43	F.	1				
Gillam	1942	26	F.		1			
Hogeman	1943	15	F.	1				
Dobson and others	1947	29	F.		1			
Gillam	1948	28	M.	1				
Cole	1948	27	F.		1			
Sherwin and Gardimer	1950	60	F.			1		
Palmer	1950	64	M.				1	
Evans and Riggs	1950	65	F.			1		
Coffey and Blumberg	1951	63	M.					1
Tagart	1952	69	F.			1		
Owens and Coffey	1953	26	F.			1		
Hill and Inglis		46	F.				1	
Total—33 cases			F. 26 M. 7	7	4	12	5	5
Operative Mortality Series of Owens and Coffey—49 cases	39 per cent			40 per cent	25 per cent		33 per cent	17 per cent
Total Series—52 cases	37 per cent			36 per cent	24 per cent		29 per cent	17 per cent

T.—Traumatic Aneurysm.

* Tamponade with ligation 8 days later.

After rupture the outlook is poor. Owens and Coffey (1953) note the relevant operative mortality as 76 per cent. The few cases which have survived are enumerated in *Table II*. The prognosis in the cases submitted to operation before rupture is somewhat happier. From their collected series, Owens and Coffey (1953) found an operative mortality of 29 per cent. This strikingly high figure which represents the results of planned approach, may well indicate the technical difficulties which may occur.

It is concluded that operation for splenic aneurysm before rupture offers a reasonable prognosis, despite

the high mortality-rate quoted above, while after such a catastrophe surgery is fraught with hazard and has been successful in but few cases (*Table II*).

CASE REPORTS

Case 1.—Mrs. H. B., aged 46 years, who had had three children, the youngest 18 years of age, had been healthy apart from diphtheria in childhood when a

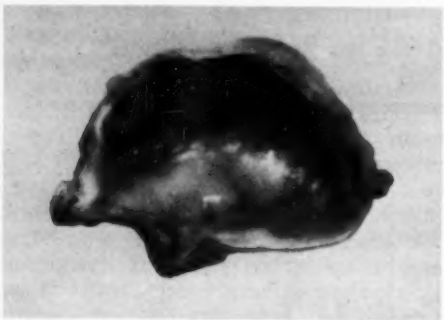

FIG. 492—*Case* 1. Aneurysm after fixation, approximately actual size.

tracheotomy had been performed. For twelve years she has complained of intermittent attacks of epigastric pain radiating to the back, lasting as long as three months, unrelated to meals but occurring especially at night and relieved by drinking milk. She has lost 1½ st. in weight in six months, during which the pain has been more severe

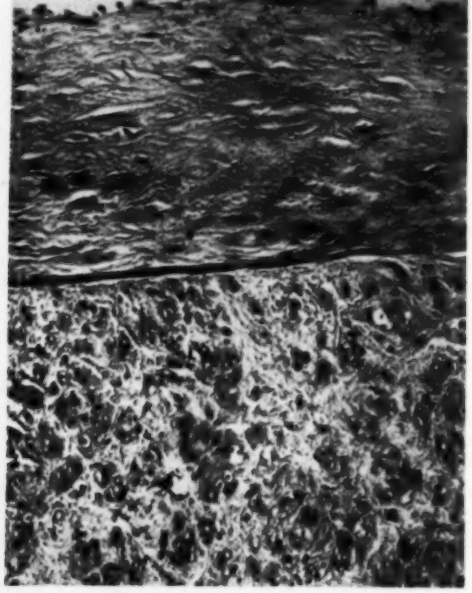

FIG. 494—*Case* 1. Section of aneurysm wall close to the afferent vessel, showing thickened intima, stretched and fragmented elastica, and replacement fibrosis of the muscular layer. (× 75.)

despite dietetic care. There had been radiological confirmation of duodenal ulcer.

She was of slim build with average nutrition and colour. There was no evident abnormality of the cardiovascular, respiratory, and nervous systems. Menstruation was regular and the genito-urinary system was normal. The abdomen presented marked tenderness to the right of the umbilicus. Blood-count: 4,000,000 red cells per c.mm., hæmoglobin 75 per cent. Wassermann and Kahn reactions negative.

AT OPERATION.—The posterior wall of the first part of the duodenum showed a chronic ulcer adherent to the pancreas. The appendix was excised. Mobilization of the stomach and inspection of the lesser sac revealed a pulsating mass, approximately 4 cm. by 3 cm., arising from the upper border of the left half of the pancreas. The wall, mostly covered by peritoneum, was grey in

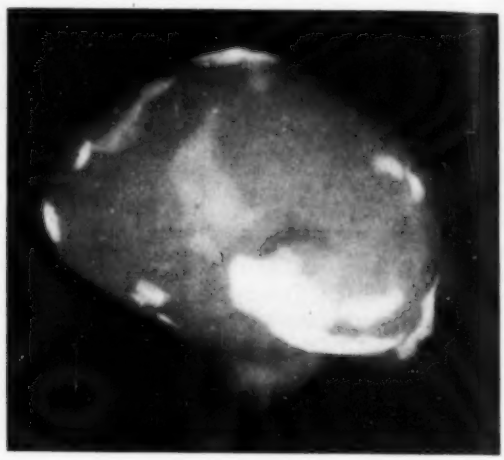

FIG. 493—*Case* 1. Radiograph of the specimen showing distribution of calcification.

colour, with white patches of tougher consistence indicative of calcification. Compression of the splenic artery reduced the pulsation of what was obviously a saccular aneurysm. The remainder of the artery was particularly straight in line and free from atheroma. The spleen was large within normal limits. The aneurysm was freed from the upper border of the pancreas. The splenic artery was ligated on each side of the aneurysm and the intervening segment was excised together with the sac. The only branch in this area was a small vessel arising distal to the sac and coursing over the fundus towards the gastrosplenic omentum. Partial gastrectomy was completed with preservation of the vasa brevia. Inspection of the spleen at this stage gave no indication of impairment of its blood-supply. It was presumed, therefore, that the vasa brevia were adequate in this respect.

Table II.—RECORDS OF CASES SURVIVING OPERATION FOR RUPTURE OF SPLENIC ANEURYSM

AUTHOR	DATE	ANEURYSM NOT IDENTIFIED	ANEURYSM IDENTIFIED
Marshall	1922		1
Brockman	1930	1	
Macleod and Maurice	1940	1	
Gillam	1942	1	
Hogeman	1943	1	
Dobson, Morse, and Covert	1947		1
Gillam	1948	1	
Coffey and Blumberg	1951	1	
Tagart	1952		1
Total—9 cases		6	3

The post-operative course was uneventful apart from a slight pyrexia for several days owing to a limited left basal pleurisy evident on radiological examination. On the twelfth day a blood-count showed 13,300 white cells per c.mm., consisting of polymorphs, 75 per cent; lymphocytes, 20 per cent; monocytes, 3 per cent;

eosinophils, 2 per cent. There was no pain or other feature suggestive of untoward changes in the spleen.

PATHOLOGICAL REPORT.—The specimen is a saccular aneurysm, 3·5 cm. in its largest diameter, with the afferent and efferent vessels lying close together on one side of the vessel (*Fig.* 492). The wall of the aneurysm is thin and has an egg-shell quality due to deposits of calcium which are demonstrated by radiography of the specimen (*Fig.* 493). The aneurysm is filled with fresh blood-clot which was easily removed revealing a smooth, shining, and apparently endothelialized surface. Atheromatous patches are present on the inner wall, but partly organized mural thrombus was not found. Histological examination shows muscle-fibres in the region of the communicating arteries, but these fibres are gradually replaced by fibrous tissue and are entirely absent from the thinner parts of the aneurysm (*Fig.* 494). The elastic lamina is present, though fragmented, in those areas which show muscle-fibres and entirely absent over the greater part of the wall. The atheromatous patches show the usual histological characters and are endothelialized.

Case 2.—Mrs. M. B., aged 68 years, had had eight children. There had been no previous illnesses apart from some hypertension and a tendency to bronchitis. For more than five years she has suffered every few weeks, and lately two or three times a week, from attacks of pain below the right costal region radiating downwards and through to the right scapula. The attacks are severe for an hour and are relieved by vomiting. Rich food is an instigating factor. There has been no jaundice. The appetite has been poor and she has lost about 6 st. in weight over the past few years. For some time there has been a large swelling in the right groin, which disappeared when she lay down, and a small umbilical hernia since a severe cough a year before.

Examination showed an elderly woman, rather thinned but of fair nutrition, with some kyphosis. The tongue was clean and she wore dentures. There was some diminution of expansion and air entry of the right upper and middle zones. The aortic second sound was accentuated and the blood-pressure 150/100 mm. The abdomen was lax, with a small reducible umbilical hernia and a large right inguinal hernia. The pelvic organs and nervous system were normal. Radiography showed no opaque gall-stones but well-marked calcification of the costal cartilages.

AT OPERATION.—The stomach was hypertrophied and dilated. Anterior and posterior duodenal ulcers produced marked stenosis and an œdematous mass fixed to the pancreas. The gall-bladder was thickened and contained eighteen faceted stones. The bile-ducts were normal. Over the upper border of the left half of the pancreas there was a hard nodule, 1 cm. in diameter, appearing to be in the substance of the pancreas, which further examination showed to be a cystic swelling in the line of the splenic artery. The base was a calcified ring and the roof thick-walled but soft, compressible but not clearly pulsatile. The remainder of the artery was straight and of normal texture. The spleen was normal. The lower ileal mesentery showed some fibrosis due to incarceration in the sac of a wide-mouthed right inguinal hernia sac. The remainder of the viscera were normal. The gall-bladder was excised. A posterior gastrojejunostomy was performed. In view of the small size and the thick walls of the splenic aneurysm and the poor pulsation of the roof, the circumstances of the patient's age and multiple lesions, it was decided to leave the aneurysm intact. The herniæ were repaired. The post-operative course was without incident.

DISCUSSION

While the splenic artery is said to be more frequently the site of aneurysm formation than any other of the small arteries within the abdomen, splenic arterial aneurysm is relatively rare. The examples described are typical saccular aneurysms arising from an atheromatous area in the segment concerned. Inspection and palpation of the remainder of the artery indicated that the degenerative process was entirely confined to this area. There was no evidence of hypertension, syphilis, or other aetiological factor in the first case, while there is a possibility of previous hypertension in the second. In his detailed review of the mode of development of aneurysms of the cerebral arteries, Carmichael (1950) concludes that the combination of factors necessary for the production of a saccular aneurysm consists of gaps in the internal elastic lamina and the muscle together with atheromatous degeneration, and that neither of these features alone is responsible. The defects occur essentially at the sites of branches. In the first case no branch was evident in the segment involved, though a small branch arose a short distance on the distal side. The focal nature of the lesion probably indicates a local degeneration of the wall of the artery as a primary change. The lack of organized thrombus within the aneurysm with corresponding minimal atheroma is probably the result of turbulence caused by the relative positions of the afferent and efferent vessels. In the second example the sac was not completely mobilized but there were no evident associated branches.

In assessing the relationship between the pathological process and the clinical phenomena it seems that the rate of repair of the degenerative lesion possibly determines whether hæmorrhage is to occur or gradual dilatation with the formation of a true aneurysm. The intermediate stage of false aneurysm results from the limiting effect of the unyielding surrounding tissues on the initial hæmorrhage. It is thus a matter of chance that hæmorrhage should occur at an early stage in the process, in one or two stages, or that a true or false aneurysm may be formed with the possibility of eventual rupture.

The clinical features, even considered in retrospect, were those of the duodenal ulcer in the first case and the ulcers and gall-stones in the second, on account of which operations were undertaken. The literature shows few examples of the coincidental discovery of an aneurysm of this type, though it is probable that the condition may often escape recognition. Successful treatment by simple excision has been recorded on only four previous occasions. It would seem unnecessary to add the further step of splenectomy in those cases of aneurysm of the main splenic artery in which the spleen is normal and the vasa brevia provide adequate blood-supply.

SUMMARY

1. Successful excision of an aneurysm of the splenic artery is reported. While splenectomy with an excision of the affected arterial segment is said to be the treatment of choice, survival following excision of the sac alone has been recorded in only 4 other cases.

2. The pathogenesis of aneurysm formation has been traced. Rupture of an aneurysm is dependent on the rate of fibrous repair in a focal lesion.

3. Splenic arterial aneurysm has been described in probably 243 cases, including those in which hæmorrhage may have arisen from a defect in the

arterial wall and where the structure of an aneurysm has been lacking. Two further cases of saccular aneurysm are added to bring the total to 245 recorded examples.

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PYELITIS GLANDULARIS

BY DAVID AIKEN

THE ROYAL INFIRMARY, DONCASTER

INTRODUCTION

Metaplastic Lesions of the Urinary Tract.—Metaplastic changes in the epithelium lining the urinary tract, which are interesting but infrequent, have received less attention in this country than elsewhere. In the bladder, epithelial metaplasia is found in exstrophy (Graham, 1942) and in the developmentally normal bladders when the mucous membrane is exposed to chronic irritation.

The occurrence of glandular epithelium in the pelvis of the ureter, however, is rare. It was first described by Paschkis in 1912 and termed ' pyelitis glandularis '. Since then only 6 cases have been published; but recently 1 case was seen by the author. This was unique in that it was associated with a squamous-cell carcinoma.

Morgagni (1761) first observed that the epithelium of the urinary tract behaved in an abnormal manner when subjected to irritation and he reported " oval hydatids hanging from the reddened inner coat of the ureter " in one patient; in another, the upper portion of the ureters contained " spherical drops of various sizes ". Von Litten (1876) described the microscopical appearance of such cysts and drew attention to their association with calculus and inflammation. He concluded that these cysts were formed by an inflammatory blocking of the crypts of the mucous membrane, the retention of the secretion in the crypts forming the cysts. Von Limbeck (1887) and von Brunn (1893) observed groups of epithelial cells in the connective tissue supporting the pelvic, ureteral, and vesical mucous membrane which they regarded as downgrowths therefrom following inflammation or irritation. The downgrowths retaining their connexion with the surface epithelium they designated epithelial buds (*epithelsprossen*) whilst others, which appeared to be isolated, they called epithelial cell nests (*epithelnestern*). The latter are now known as ' Limbeck-Brunn nests ', or briefly as ' Brunn's nests '.

Brunn's nests may occur in the bladder, ureter, or renal pelvis and are usually present in the exstrophic bladder, where their development can be readily studied following irritation of the mucosa by infection and clothing. Aschoff (1894) confirmed von Brunn's work and suggested that the cell nests were formed not only by downward proliferation of the deeper layers of the urinary epithelium, but also by growth of the submucosal tissues which proliferate under and around the surface epitheluim, and so isolate cell nests. In time a lumen may appear in the centre of the cell nests and as the quantity of fluid increases sessile or pedunculated cysts lined by flattened epithelium develop, or the cells surrounding the early cysts may assume the characteristics of secretory epithelium with basally placed nuclei. The former condition constitutes pyelitis, ureteritis, or cystitis ' cystica '. The latter condition is called pyelitis, ureteritis, or cystitis ' glandularis '.

The method of origin of the central lumen in the epithelial cell nest is doubtful. Von Brunn (1893), Lubarsch (1893), Aschoff (1894), and Morse (1928) believed it to be degenerative in nature. Stoerck and Zuckerkandl (1907) concluded that the cysts are produced by a secretory action of the cells and represent a " latent capacity of this mucous membrane for gland formation ". Similar cystic or glandular change may occur in the ' epithelial buds '. Stirling and Ash (1941), however, did not accept the cell nest theory. They claimed that the isolated ' cell nests ' are only apparent and that serial sections demonstrate their continuity with the surface epithelium. These authors suggested that the subsequent fate of the ' cell nest ' depends on whether the epithelium becomes stratified or glandular.

The theories of the earlier writers were challenged by François (1913), who believed that glandular epithelium in the urinary tract arose in embryonic rests formed during division of the cloaca into rectum and urogenital sinus. Enderlen (1904), and Formiggini (1920) discovered independently that in congenital exstrophy the mucosa of the bladder reveals no signs of glandular or cystic formation at birth but later develops mucous glands similar to those of the rectum. Morse (1928) stated that glandular structures are not found in the normal urinary tract above the trigone of the bladder. Zuckerkandl (1911) asserted that the theory of developmental origin has no basis and that the change is undoubtedly a metaplasia of the epithelium. Furthermore, Patch and Rhea (1935) have traced the progressive development of Brunn's nests from the earliest stages until the stage of glandular formation, and they are satisfied that the latter condition arises as a metaplasia of the epithelium due to chronic irritation.

To what causes, then, may these pathological conditions be ascribed? A study of the literature on proliferative lesions of the upper urinary tract reveals that in all the reported cases the patients had present or previous infection of the urine, although no specific organism is noted (Hinman, Johnson, and McCorkle, 1936; Stirling, 1942). It is now agreed that proliferative and metaplastic changes in the renal epithelium are associated with chronic irritation by infective agents, but are most marked where mechanical influences are superadded. Mechanical influences alone may suffice to induce the change.

CASE REPORT

W. W., male, aged 49, came to Mr. H. Blacow Yates's Out-patient Clinic at the Sheffield Royal Hospital on Feb. 8, 1949, with the following history:—

1921: Stones were removed from the left kidney through a loin incision.

FIG. 495.—Section of the renal pelvis. A, The lining here is a narrow stratified epithelium (*see Fig.* 496). B, The transition from stratified to columnar epithelium with goblet cells (*see Fig.* 497). C, Groups of mucous alveoli (pyelitis glandularis) (*see Fig.* 498). The goblet cells and alveoli contain mucin. (Mayer's mucicarmine stain) (*see Fig.* 499). D, Cysts lined by flattened epithelium (pyelitis cystica) (*see Fig.* 500). E, Squamous-cell carcinoma with cell nests. (*see Fig.* 501). (× 10).

1925: Advice sought on account of a discharging sinus in the left loin. Calculi were again removed from the kidney.

1932–3: An 'abscess' of the left kidney developed and was drained.

1936: X-ray examination by intravenous pyelogram: *Left kidney*, not secreting, several calculi present; *Right kidney*, functioning.

Urine culture, hæmolytic streptococci.

1937: A perinephric abscess of the left kidney was drained.

1949 (Feb. 8): The patient came under our care with a discharging sinus at the lower end of the left loin incision. He had felt tired and weak for a few days and during that time he had two rigors. He had no frequency of micturition.

ON EXAMINATION.—Apart from the sinus and some tenderness and rigidity in the left loin on bi-manual examination, nothing abnormal was found. His blood-pressure was 130/80 mm. Hg.

Laboratory Findings.—

1. *Midstream urine*: Reaction, acid. Albumin, dense cloud. Microscopy, many pus cells and a few epithelial cells. Culture, yielded a moderate pure growth of hæmolytic streptococcus which was sensitive to penicillin.

2. *Culture of pus from sinus*: a moderate pure growth of hæmolytic streptococcus which was sensitive to penicillin. Ziehl-Neelsen film, no evidence of *Mycobacterium tuberculosis*.

3. Wassermann reaction, negative; Blood-urea, 34 mg. per cent.

Radiological Examination.—Excretion urogram, non-functioning left kidney with numerous small calculi; right kidney normal. *Radiograph of chest*, both lung fields clear.

Cystoscopy.—Mild generalized cystitis. No cystitis cystica or evidence of tubercles.

PRE-OPERATIVE MEASURES.—He was given penicillin 6-hourly for ten days. This cleared his urine of organisms but the sinus continued to discharge.

AT OPERATION (April 8).—The previous loin incision was opened and a very fixed kidney, from which oozed foul-smelling yellow pus, was mobilized with difficulty and removed together with the upper 4 cm. of the ureter. The dense, fibrous bed surrounding the kidney was drained and the wound closed.

POST-OPERATIVE COURSE.—This was uneventful. He was discharged three weeks after operation with the incision healed.

DESCRIPTION OF SPECIMEN.—

1. *Gross.*—The excised kidney was an irregular mass which measured 10 × 7 × 5 cm. Parts of it felt rubbery, suggesting coarse fibrous tissue; other parts were friable and easily fragmented. On incising the kidney the grittiness of calcification was apparent. The normal renal architecture was completely obliterated by fibrosis and cavitation. Irregular calculi, about 1 cm. in size, occupied several abscess cavities.

2. *Microscopical.*—The lining of the renal pelvis showed three variants from the usual transitional epithelium (*Fig.* 495).

a. In part, a narrow stratified epithelium supported by stroma and strands of smooth muscle occurred (*Fig.* 496).

b. An abrupt transition from stratified to columnar epithelium interspersed with goblet cells was observed (*Fig.* 497). Several small indentations resembling simple tubular glands occurred near the transition. About half of the pelvic mucosa was replaced by this glandular type of epithelium. In the supporting stroma, which was heavily infiltrated with lymphocytes and interspersed with smooth muscle-fibres, groups of mucous alveoli were seen (pyelitis glandularis) (*Fig.* 498). Mayer's mucicarmine stain demonstrated that mucin was present within the goblet cells and alveoli (*Fig.* 499). Cysts lined by flattened epithelium (pyelitis cystica) were found (*Fig.* 500), but Brunn's nests were not observed.

c. Another region of the pelvic mucosa was involved in malignant change of an epitheliomatous nature. A typical squamous-cell carcinoma with cell nest formation was present (*Fig.* 501). The epithelioma protruded into the cavity of the ureteric pelvis and invaded the ureter.

The Kidney.—This was composed mainly of coarse fibrous tissue amongst which were lymphoid nodules with germ centres. The arteries showed great thickening and often occlusion, and calcium deposits were present in the media. Groups of epithelioid cells set in a background of fibrils and polymorphs and liberally studded with multinucleated giant cells were found in some areas and spots of calcification were present in these foci. In

FIG. 496.—The lining here is a narrow stratified epithelium. (× 27.)

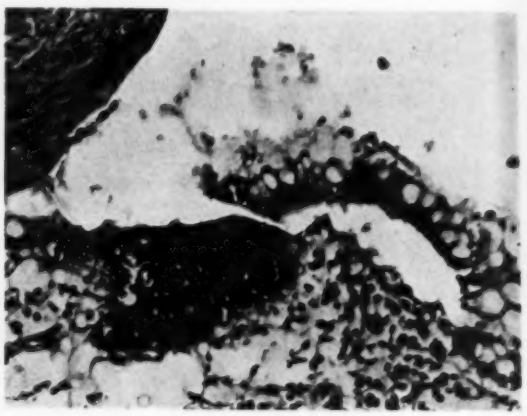

FIG. 497.—The transition from stratified to columnar epithelium with goblet cells. (× 153.)

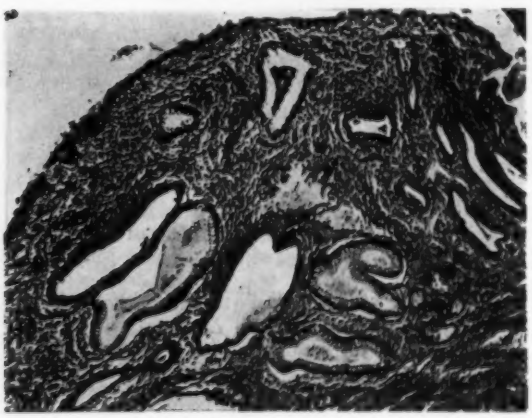

FIG. 498.—Groups of mucous alveoli (pyelitis glandularis). (× 67.)

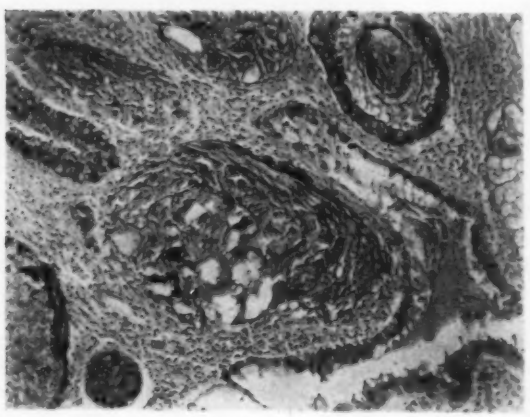

FIG. 499.—Goblet cells and alveoli contain mucin. (Mayer's mucicarmine stain.) (× 61.)

spite of these changes, kidney tissue was still recognizable by infrequent tubules and isolated glomeruli (*Fig.* 502).

PROGRESS.—The patient remained well for one year (Feb. 17, 1950), when he developed an abscess in the centre of the left loin incision. This discharged spontaneously and a sinus persisted. A radiograph of the renal area showed no evidence of foreign body or other abnormality. Culture of the pus from the sinus yielded a mixed growth of *B. coli* and *B. pyocyaneus*. Tubercle bacilli were not found. Urine culture yielded a pure growth of *B. coli*. The sinus was dressed for four months, but the discharge became more profuse. He was admitted to the ward on June 8 for investigation.

FIG. 500.—Cysts lined by flattened epithelium (pyelitis cystica). (× 47.)

Cystoscopy.—Mild generalized cystitis was observed. A ureteric catheter was passed into the left ureter for 4 cm., where it met with obstruction.

Radiological Examination.—Contrast medium injected into the catheter outlined the ureter and filled an irregular cavity opposite the third lumbar vertebra. It was not possible to demonstrate a communication between the cavity and the sinus in the loin, but it was thought that the latter might be connected with the chronically infected ureter.

At Operation (June 12).—A very adherent left ureter, 1 cm. in diameter and 20 cm. in length was removed through an iliopelvic incision. The upper end of it communicated with the irregular cavity recognized on radiography, and this in turn opened on to the skin by a sinus 2½ in. in length. The sinus was curetted and the curettings and ureter were sent for examination.

Report: The upper end of the ureter was involved in squamous-cell carcinoma. The lower end showed chronic inflammation and loose keratinized debris in the lumen. The curettings from the sinus were fragments of squamous-cell carcinoma and associated inflammatory reaction.

Post-operative Course.—The incision healed by first intention but the sinus continued to discharge. The patient went home 24 days after operation and arrangements were made for a course of deep X-ray therapy. This temporarily arrested the discharge from the sinus, but four months later he developed rigors and an abscess again appeared in the loin. The abscess was drained but the carcinoma was advancing locally and he had severe pain in the back. He gradually went downhill and died at home on Dec. 26, from bronchopneumonia. A post-mortem examination was not obtained.

DISCUSSION

A study of the literature reveals that in the urinary tract the bladder is the most frequent site of such proliferative and neoplastic lesions, the renal pelvis being rarely involved. Pyelitis cystica has been described on numerous occasions, notably by Patch (1939) and Stirling (1942). On the other hand pyelitis glandularis is a rarity and has been reported only 6 times (Paschkis, 1912; Brütt, 1923; Plaut, 1939; Foot, 1944; Ackerman, 1946; and Torassa, 1948). Paschkis stated that the changes in the pelvis of the ureter are analogous to those in the bladder, and that glands occur only when chronic inflammatory processes are at work. He mentions that pyelitis glandularis may be associated with malignant tumours.

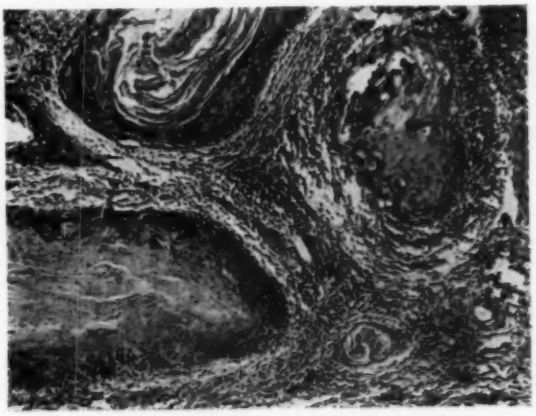

FIG. 501.—Squamous-cell carcinoma with cell nests. (× 40.)

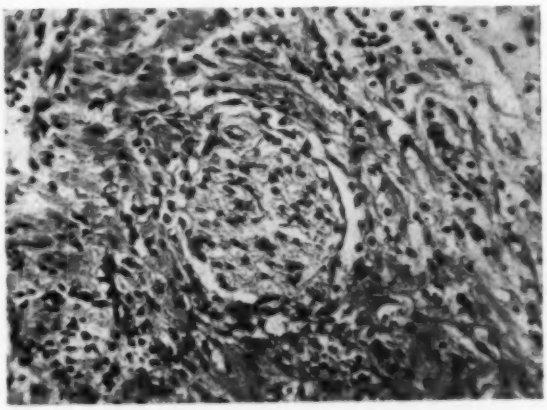

FIG. 502.—An isolated glomerulus in the kidney. (× 144.)

That the changes mentioned are metaplastic rather than developmental in origin is now generally accepted. All the reported cases had long-standing renal infection, all had renal calculi, and the affected kidneys were generally non-functioning, though this point was not stressed by the authors. In my patient the kidney was non-functioning, grossly infected and fibrosed, and contained calculi for which operations had been carried out over thirty years. I believe that loss of renal function plays an important part in the development of pyelitis glandularis. The flow of urine from the kidney removes epithelial debris and tends to keep the mucosa pliable and soft and to protect it by a cushioning effect from the constant irritation of the ever-present calculus. This view is supported by the observation that in

exstrophy of the bladder, glandular formation tends to be more marked in the dry peripheral areas than around the constantly moist ureteric openings. It is suggested, therefore, that inflammation, mechanical irritation, and loss of renal function are the leading factors in the production of pyelitis glandularis. The recent work of De Navasquez (1950) lends support to this view as regards septic infection. He produced staphylococcal pyelonephritis by intravenous injection of staphylococci and found, in his longest surviving rabbit (6 months), that focal depressed scars extended through the whole thickness of the kidney, and that the epithelium of the collecting tubules and pelvis had become columnar. He attributes this remarkable change to metaplasia as a result of chronic infection.

Four of the cases recorded in the literature were unaccompanied by tumour formation, but in those of Plaut (1939) and Ackerman (1946) there was an associated mucinous adenocarcinoma. The author's patient is unique in that it is the first reported instance of pyelitis glandularis and squamous-cell carcinoma in the same specimen. The relationship between leukoplakia, cystitis cystica, and squamous-cell carcinoma, and that between cystitis glandularis and mucus-secreting adenocarcinoma of the bladder has been fully discussed by Patch (1929) and by Patch and Rhea (1935). They point out that these conditions in the bladder are likely to undergo carcinomatous change; squamous-celled in the one, adenocarcinomatous in the other. The same relationship would appear to apply in my specimen, where the epithelium in the renal pelvis exhibits two distinct types—namely, stratified and columnar-cell. The stratified epithelium has undergone further transformation into epithelioma. The appearance in the present example of the two types of epithelium and the presence of cystic and glandular formations suggests that all these lesions should be regarded together as proliferative with possible metaplastic changes which may occur in the course of any long-standing irritation of the urinary tract. O'Flynn (1950) states that " such diverse responses to chronic irritation have not been demonstrated in the epithelium of the pelvis or ureter, although it seems not unreasonable that they might occur ". Our histological sections support the latter part of his statement and also Torassa's (1948) opinion that there is a relationship between pyelitis glandularis and pyelitis cystica. Once epithelial metaplasia has taken place the danger of malignant change is ever present, and for this reason nephrectomy is advisable whenever chronic renal infection or calculus has rendered the kidney functionless or almost so. Efforts to save a severely damaged kidney associated with calculi are not justified.

SUMMARY

1. The genesis of cysts and glands in the urinary tract has been discussed.

2. The epithelium of the urinary tract, when exposed to chronic irritation—thirty years' history in the present patient—may undergo metaplastic changes.

3. Glandular metaplasia may occur when urinary secretion is absent or diminished.

4. A case of pyelitis glandularis associated with a squamous-cell carcinoma is presented. This combination has not been reported before.

5. Nephrectomy was performed, but recurrence of the carcinoma took place with a fatal outcome.

I wish to thank Mr. H. Blacow Yates for his help and permission to operate upon this case and to publish it.

I acknowledge the great kindness of our pathologist, Dr. J. L. Edwards, for much help with the pathological report and for his encouragement to undertake this study.

I am also indebted to Dr. E. R. A. Cooper, of the Department of Anatomy, University of Manchester, for help with the histology. Her advice has been invaluable in compiling the paper.

To Mrs. E. K. Dawson, of Edinburgh, and to Mr. Jas. B. Macalpine I owe thanks for helpful criticism.

The histological sections were prepared by Mr. D. E. Bradey and the colour photographs by Mr. A. K. Tunstill.

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A CASE OF DUPUYTREN'S CONTRACTURE INVOLVING THE HAND AND FOOT IN A CHILD

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Although cases of Dupuytren's contracture in young people have been referred to by various authors (Kanavel, Koch, and Mason, 1929; Ross and Annan, 1951) and contracture involving the plantar fascia is well recorded, we can find no record of a case involving the hand and foot in a child. This case is presented, therefore, as what we believe to be an extreme rarity.

Fig. 503.—The right hand showing the deformity before operation.

CASE REPORT

History.—S. T., a boy of 14 years was referred to the Orthopædic Clinic of the Royal Liverpool Children's Hospital by Dr. Myerscough with " A fibrous contracture of the ring and little fingers of the right hand and of the plantar fascia of the right foot, probably a juvenile type of Dupuytren's contracture ".

The condition of the plantar fascia had been present for four years and that of the hand for three years. There was no history of trauma or of systemic general infection and a careful inquiry disclosed no similar condition in the family as far back as the grandparents (Koch, 1933).

On Examination.—

The Hand.—There were flexion contractures of the ring and little fingers of the right hand (*Fig.* 503) affecting the metacarpophalangeal joint of the ring finger and the proximal interphalangeal joints of both fingers. The dorsal thickenings referred to by Kanavel, Koch, and Mason (1929) were found over the proximal interphalangeal joints of the right ring finger and over the left little finger (*Fig.* 504), this latter being the only clinical involvement of the left hand. The firm fibrous pretendinous bands were palpable on the palmar aspects of the right ring and little fingers and early pitting of the palmar skin at the bases of these fingers was noted; this is well shown in *Fig.* 503.

The Foot.—This showed a firm fibrous contracture of the plantar fascia, which was greatly thickened in the middle of the sole of the foot and densely adherent in this area. Early cavus deformity was present with mild clawing of the toes (*Fig.* 505). Considerable pain had been experienced from pressure on the thickened area in the sole.

Fig. 504.—The left little finger showing the dorsal thickening referred to in the text.

No other fibrous contracture was present beyond these recorded and there was no evidence of penile fibrosis (Peyronie's disease).

Total excision of the affected areas was advised.

At Operation.—

Hand.—Under a pneumatic tourniquet the contracted palmar fascia was excised by careful sharp dissection, the digital prolongations being removed through mid-lateral incisions placed in the interdigital borders of the affected fingers. Great care was taken to free the digital nerves from the contracted tissue in which they were incorporated (Koch, quoting Mason, 1933). Complete passive extension was then possible. No splintage was employed in the immediate post-operative period.

Foot.—Through an elliptical incision the whole of the plantar fascia was excised, paying regard to the

FIG. 505.—The right foot showing the condition before operation.

FIG. 506.—The foot after excision of the plantar fascia.

FIG. 507.—The right hand after excision of the contracted fascia, note the complete range of extension.

FIG. 508.—The right hand after excision, showing the complete range of flexion.

underlying vessels and nerves. The fibrous nodule in the sole was densely adherent to the skin of the foot and was separated by sharp dissection.

POST-OPERATIVE CARE.—The foot made an uninterrupted recovery, with improvement in the cavus deformity and complete freedom from pain (*Fig.* 506).

The Hand.—After four days the dressings were removed and replaced by a less bulky type; light metal splintage being applied to maintain the corrected position, although there was no tendency to further contracture. The sutures were removed at the tenth day, after which active finger exercises and paraffin wax baths were instituted and the splintage used at night only. At the twenty-first day all splintage was discontinued and full active and passive movements were present and have remained. *Figs.* 507 and 508 show the results obtained in the right hand.

Tissue from both hand and foot was sent for investigation.

PATHOLOGICAL REPORT (Dr. Jones).—"The appearance is of a very active fibrous-tissue proliferation. In some areas the tissue is very cellular, with very little intercellular substance. In others there is dense collagen. This latter appears to surround the former as a sort of capsule. Here and there are areas of round-cell infiltration. The appearances of hand and foot are similar. (*Figs.* 509, 510.)

FIG. 509.—The fibrous tissue from the palmar fascia. H. and E. (× 63.)

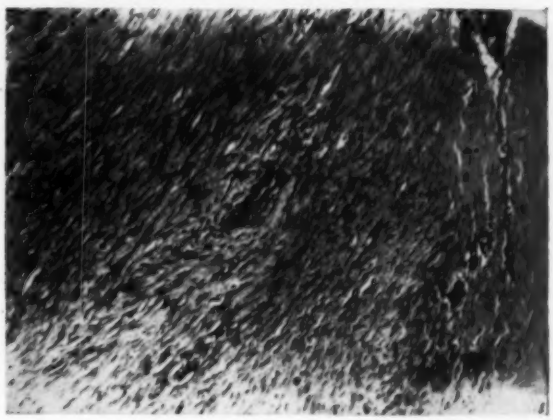

FIG. 510.—The fibrous tissue from the foot. H. and E. (× 63.)

DISCUSSION

Although the condition is very rare in one so young, this case shows all the clinical and pathological features of Dupuytren's contracture, and comparison with the reports of the pathological investigations of Meyerding, Black, and Broders (1941) shows an identical histological appearance. We are, therefore, in no doubt as to the accuracy of the description of the case as one of Dupuytren's contracture.

The operative findings in the hand confirm the involvement of the digital nerves described by Mason (Kanavel, Koch, and Mason, 1929) and emphasize the necessity for a clear operative field and careful surgery.

Dupuytren (1832) describes his case and says: "I cut through the prolongations extending from the fascia to the fingers: the state of contraction immediately ceased and the slightest effort was sufficient to bring them to complete extension . . . the joints also were in a healthy state, the bones were neither swollen nor changed in any degree. I could distinguish no alteration of the articular surfaces or ligaments. The synovial membrane and the synovial cartilages, all were sound."

The free passive movement noted in the hand after dissection is in accordance with this, and the lack of tendency to recurrence differs markedly from that noted following subcutaneous fasciotomy, when post-operative splintage is an essential, and complete passive extension but rarely regained.

It will be seen from the photomicrographs that the fibrous tissue is in a high state of activity, and it seems likely that total excision is a more rational procedure at this stage, when no undue skin involvement has occurred. Subcutaneous fasciotomy, if it is carried out, might be reserved for inactive 'ripe' contractures in older people, when the advantage of fascial excision may be outweighed by the simplicity of subcutaneous fasciotomy. It seems that to employ subcutaneous fasciotomy in an active juvenile case would be to court the possibility of early recurrence. We suggest, therefore, that cases of Dupuytren's contracture be attacked earlier in their history, by excision of the involved fascia before deformity and skin involvement render necessary the more extensive plastic procedures advised by Kanavel, Koch, and Mason (1929). The difficulty is, of course, that patients do not present themselves for treatment before contracture is well established.

Subsequent review of this case has left us wondering whether or not the fibrosis may represent a local collagen disorder or polyfibrosis, and whether or not the process might be modified or arrested by local injection of hydrocortone into the affected areas. We propose to investigate this should we encounter an early case in the near future.

SUMMARY

1. A case of Dupuytren's contracture in the hand and foot in a child of 14 years is presented.

2. Total excision of the affected areas was carried out.

3. It is suggested that where an early active contracture is encountered, excision has advantages over subcutaneous fasciotomy.

4. From consideration of the clinical and pathological features it is suggested that local hydrocortone therapy might be a rational therapy for the early case.

Our thanks are due to Professor Bryan L. McFarland for permission to publish the case, and to the Central Photographic Department for the photographs other than the micrographs.

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RESECTION OF THE AORTIC BIFURCATION FOR RELIEF OF A MYCOTIC ANEURYSM OF THE LEFT COMMON ILIAC ARTERY, AND ITS REPLACEMENT BY A PRESERVED ARTERIAL GRAFT

WITH A DISCUSSION OF THE TREATMENT OF ANEURYSMS, ILLUSTRATED BY THREE FURTHER EXAMPLES

BY H. D. MOORE AND MAXWELL TELLING, LEEDS

THE purpose of this report is to present the considerations which led to such an operation on a healthy young woman whose symptoms were only mild; to record the details of the operation and its result; to review briefly the literature of aneurysms before and after the introduction of antibiotics; and to discuss the treatment of aneurysms, especially by graft replacement, for the benefit of surgeons who from the rarity of the condition, will have little chance of becoming familiar with these procedures.

Case 1.—On April 9, 1951, a previously healthy woman of 21 was admitted to hospital with a six weeks' history of progressive fever, malaise, night sweats, and pain and stiffness in the limbs and joints. She was extremely ill, T. 101° F., P. 120, R. 20, and a harsh apical systolic murmur was widespread over the precordium; the spleen could not be felt. A diagnosis of acute rheumatism was made and she was treated by salicylates. On April 12 the B.S.R. (Westergren, 200-mm. column) was 140 mm. in 1 hour, and the blood-count Hb. 50 per cent, R.B.C. 2,600,000, W.B.C. 7000; the differential count was 80 per cent polymorphs, 13 per cent lymphocytes, and 3 per cent primitive cells. A week after admission her condition had deteriorated gravely; she was delirious, bleeding from the gums, and hæmoglobin and red cells had fallen to 34 per cent and 1,800,000 respectively; the platelets numbered 140,000 per c.mm. On April 17 she was seen by one of us (M. T.), and it was felt that the diagnosis lay between fulminating leukæmia and subacute bacterial endocarditis; the urine was sterile but contained many red cells. Sternal marrow puncture excluded leukæmia, and treatment with 3,000,000 units a day of soluble penicillin was begun. On April 19 a blood-culture taken on April 17 was reported positive. Despite transfusion of two pints of whole blood, improvement did not really take place until on May 6 the dosage of penicillin was increased to 6,000,000 units daily.

The only positive blood-culture was that of April 17, which yielded a " heavy growth of long-chained streptococcus after 48 hours. Subculture has proved impossible, but the streptococcus does not appear to be hæmolytic ". During the earlier weeks of the illness, the systolic apical murmur varied greatly in quality and in intensity, and then began to disappear steadily; red cells were constantly found in the urine: transient splenomegaly was noted; and on May 6 the patient had a cerebral embolism with sudden loss of consciousness and left hemiplegia, from which fortunately she made complete recovery. The only check in her convalescence was a large sterile painless abscess which had formed in the right buttock at the site of the penicillin injections and which had to be drained. A final diagnosis of bacterial endocarditis was made, and she was discharged fit and well on Sept. 7.

By January, 1952, the patient was working full time, and during 1952 the systolic apical murmur finally disappeared. Her general condition remained excellent until Feb. 27, 1953, when she reported a pain down her left leg which had been present intermittently for two months. A large pulsating tumour, over which a systolic murmur could be heard, was found in the left lower abdomen. Mycotic aneurysm was diagnosed, and shown by aortogram to arise from the left common iliac artery at its origin from the aorta (*Fig.* 511, A). It was also beginning to erode the fourth and fifth lumbar vertebræ.

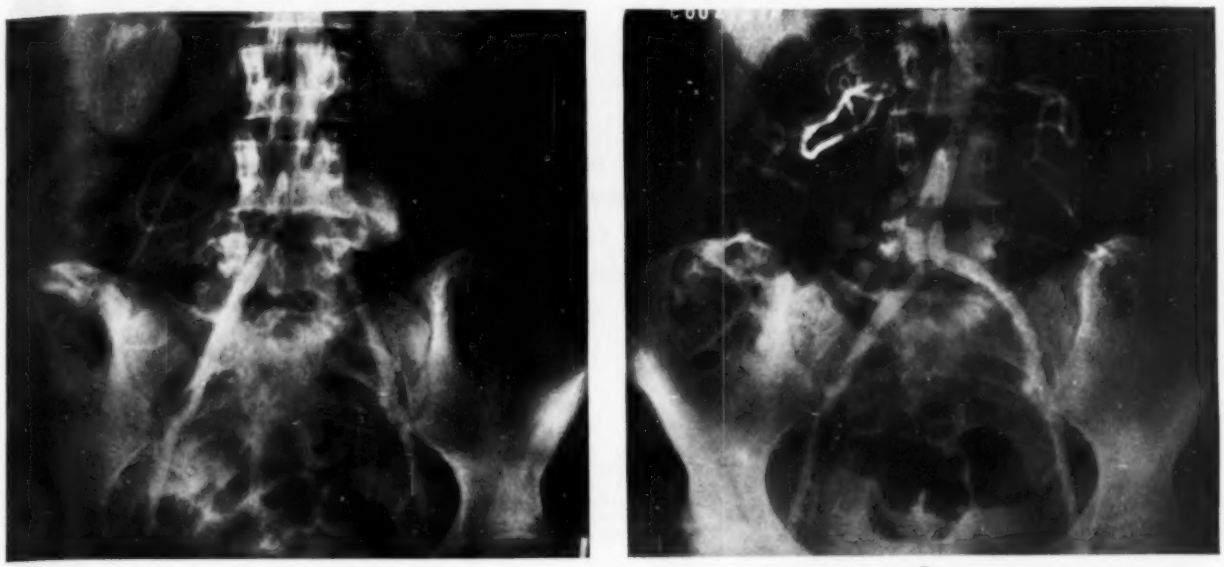
Operation was considered essential, but it was hoped that the main vessel could be repaired. In case this should prove impossible, a graft was prepared, consisting of the abdominal aorta and common iliac arteries of a man of 21 who had been killed in an accident. The graft was taken with sterile precautions within 3 hours of death, stored in the solution recommended by Gross and his associates (Gross, Hurwith, Bill, and Peirce, 1948) and, as it turned out, used within three days of storage.

AT OPERATION (March 26).—A left paramedian incision was made, the gut packed upwards, and the posterior peritoneum divided in the midline. The left colon and its vessels and the left ureter were retracted to the left, the mesentery of the small bowel, the right ureter, and right colon, to the right.

The aneurysm (*Fig.* 512) was about 6 in. long by 4 in. wide, and arose from the left common iliac artery at its origin from the aorta. It was bulging laterally and backwards, destroying the posterolateral part of the left common iliac artery; the posterior wall was densely adherent to the lumbar vertebræ and transverse processes and was burrowing into the iliopsoas muscle. The posterolateral wall of the aneurysm was thin, but lining the anterior wall was a fairly thick layer of clot. The sac had no neck, and repair of the common iliac artery was impossible. The left common iliac vein was adherent to the sac, but otherwise normal.

The aorta and both common iliac arteries were controlled with tapes and an attempt made to mobilize the aneurysm, but it was too firmly fixed. The tapes were therefore tightened to occlude the vessels, and in addition a Blalock clamp was placed on the aorta. The aneurysm was then incised, but the flow of blood was so great that the incision had to be closed. Several vessels entering

the aorta at the bifurcation were then ligated, and bleeding from the aneurysm ceased. The aorta was divided just above the bifurcation, the lower end closed, and the graft in between; the same procedure was repeated on the right side. The lower clamps were released and then the upper. The aortic and left iliac anastomoses were



A B

FIG. 511.—A, Aortogram March 17, 1953. The aneurysm of the left common iliac artery at its junction with the aorta. The external diameter of the aneurysm was much larger than the part filled with diodone. B, Aortogram, Sep. 10. Slight narrowing of the aortic anastomosis at the upper margin of fourth lumbar vertebra. The bifurcation of the graft is lying between the fourth and fifth lumbar vertebræ, but the first parts of the common iliac arteries are adherent to each other. The left iliac anastomosis is probably at the lateral margin of the lower border of the fifth lumbar vertebra, while the right is probably just where the two vessels separate.

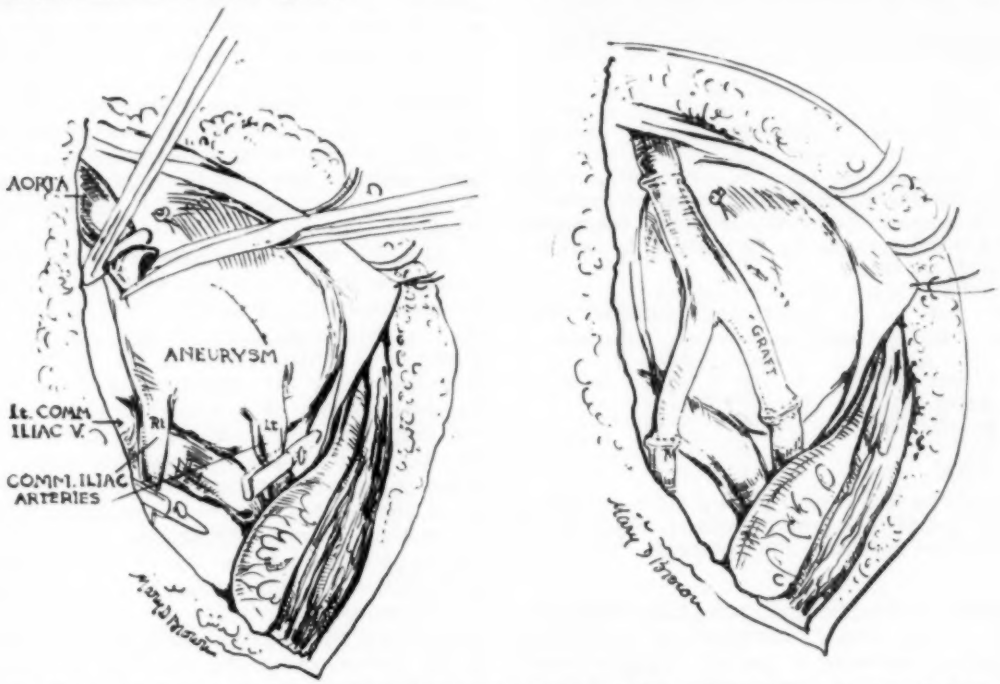


FIG. 512.—Drawings made at the operation showing the aneurysm and the method of reconstitution of the aorta and common iliac arteries with a preserved arterial graft.

sutured to the aorta, using two everting stay sutures and, in between, continuous everting sutures of 5/0 black silk. The left common iliac artery was then ligated and divided just below the aneurysm; being a little smaller than the graft, it was cut obliquely and then sutured to the graft, using two stay sutures and continuous everting stitches satisfactory after one or two additional stitches had been placed, but that on the right bled briskly; it was accordingly remade. The aneurysm was not excised because mobilization had already proved impossible and because it did not seem too big for absorption. The risk of necrosis and suppuration in this patient seemed small,

but these complications have been reported when a very large devascularized sac is left (Lam and Aram, 1951; Cooley and de Bakey, 1952). The peritoneum was repaired over the vessels and the abdominal wound closed. The aorta and iliac vessels were occluded for about one hour in all. The only real difficulties of the operation arose because it had not been appreciated that *all* vessels entering the aneurysmal area must be controlled, otherwise the flow of blood when the aneurysm is incised is considerable; and because attempts were made to remove the sac intact, which was not only most difficult but unnecessary.

PROGRESS.—Immediately after operation all the pulses in the left leg were palpable and strong. The femoral pulse in the right leg was normal, but the lower pulses were very doubtful, although the circulation of the leg was obviously adequate. Further progress was uneventful and the circulation of both legs was good when the patient was discharged on April 13, although only the femoral pulse of the right leg was definitely present. Follow-up showed an excellent clinical result; the patient had returned to full work during May, and could walk for miles and dance for hours.

In September, 1953, a second aortogram (*Fig.* 511, B) showed the graft to be functioning perfectly. The oscillometric readings were:—

	Right	*Left*
Upper thigh	15	15
Above knee	10	15
Below knee	10	15
Calf	6	10
Ankle	2	8

No pulses could be felt in the right leg below the knee. There was no change at the end of January, 1954, except that on abdominal palpation the aneurysm was much smaller.

Discussion.—Mycotic aneurysms have long been recognized. Koch (1851) described an aneurysm of the superior mesenteric artery (which burst) associated with valvular vegetations, but Tufnell (1853) seems to have been the first to correlate the two conditions (earlier Rokitansky, in 1844, had described emboli in vessels with destruction of the arterial wall).

These aneurysms most often affect the aorta and its visceral branches (Lewis and Schrager, 1909; Stengel and Wolforth, 1923) but any vessel may be involved. They are usually small and often multiple, but most reports are of patients who died either from the endocarditis or from rupture of the aneurysm before the discovery of antibiotics. Osler (1885), however, described one the size of a billiard ball, and those described by Blakemore (1947), and by Fernback, Berman, and Cohen (1952), were even larger. The organism is usually a streptococcus derived from the vegetations on the cardiac valves, but it may be a staphylococcus, pneumococcus, or gonococcus, and may also arise from the lungs, bones, etc. (Stengel and Wolforth, 1923; Reifenstein, 1924).

Table I.—EXPECTATION OF LIFE OF PATIENTS WITH AN ANEURYSM

SITE	AUTHOR	SOURCE OF MATERIAL	NUMBER	DEATHS	REMARKS
All areas	Colt, 1926	Post mortem	707	707	Average survival 20·8 mth.
Abdominal aorta	Bryant, 1903	Post mortem	54	54	Average survival 15 mth. (15 d. to 9 yr.).
	Nunneley, 1906	Post mortem	32	32	Average survival 13 mth. (from 53 wk. to 12 yr.).
	Habershon, 1863	Hospital admissions	13	13	Survival from a few weeks up to 8 yr.
	Osler, 1905	Hospital admissions	16	10	—
	Nixon, 1911	Hospital admissions	233	154	The survivors suffered severe symptoms
	Kampmeier, 1936	Hospital admissions	68	68	66 per cent died in hospital
Peripheral vessels	Poland, 1869	Hospital admissions	120		All were subclavian
			35 "no treatment"	21	14 "healed spontaneously"
			25 "medical treatment"	8	
			60 operated upon	43	All deaths were caused by the operation
	Allbright and Van Hale, 1946	War wounds	23		18 developed severe complications from expansion or rupture within 6 mth.
	Gifford, Hines, and Janes, 1953	Hospital admissions	100		All popliteal. Most ruptured or produced gangrene within 3 yr. unless operated upon.

The incidence of mycotic aneurysm is difficult to assess; from 1851 Stengel and Wolforth (1923) collected 217 from the literature, while Garland (1932) found 4 out of 178 aneurysms in 12,100 autopsies at the Leeds General Infirmary. Only an occasional one has been successfully operated upon (Klein and Crowel, 1946; Blakemore, 1947; Fernback and others, 1952).

Mycotic aneurysms have a strong tendency to rupture, as their origin would suggest and experience has confirmed (Koch, 1851; Stengel and Wolforth, 1923; Fernback and others, 1952). Accurate prognosis is difficult, because few reports have been published since the introduction of antibiotics and the development of vascular surgery. Until about five years ago nearly all patients died within seven months of the onset of the endocarditis. Now, however, the endocarditis can generally be controlled: so, if the patient survives long enough to form a mycotic aneurysm which can be recognized clinically the prognosis should be that of the aneurysm alone, unless the endocarditis recurs or cannot be controlled.

Whatever the nature of the aneurysm, the justification for operation must be either the severity of the symptoms or the poorness of the prognosis if the aneurysm is left. *Table I* shows clearly how bad is the general prognosis of aneurysms.

Table I also shows that some patients will live for many years, and that the aneurysm may even resolve without treatment. Stewart and Garland (1932) describe a man first seen in 1899 with a large syphilitic aneurysm of the aortic arch, who was given a very gloomy prognosis. Yet he lived a normal life for the next 29 years and eventually died

of a hypernephroma with the aneurysm intact. Treatment must therefore be based on general probabilities which, as *Case* 2 shows, may well be wrong.

Case 2.—A man of 48 developed a sudden pain in the groin while at work in April, 1951. He was found to have an aneurysm in the right groin, about 2½ in. long by 2 in. wide, in the line of the femoral artery. Aortogram (*Fig.* 513) showed that the aneurysm involved the proximal few inches of the femoral artery; the lumen of the vessel was not greatly changed, so it was thought that the aneurysm was largely clotted and probably would not increase in size. In September, 1951, the patient again felt a sudden pain and the swelling in the groin increased rapidly. He was found on admission to hospital to have an enormous swelling of the front of the upper thigh and groin where the aneurysm had burst and the blood had spread into the tissues: he subsequently died.

Table II makes it evident that no single surgeon, except in warfare or over many years, is likely to see more than a few aneurysms or to become familiar with their treatment. A brief discussion of their treatment is therefore justified, as illustrated by *Case* 1 and by two more which came under the care of one of us (H. D. M.).

The aim of any operation upon an aneurysm is to restore to normal the main arterial pathway; failing this to remove or to occlude the aneurysm, or to strengthen its wall from without, while preserving an adequate collateral blood-supply to the periphery.

The earliest workers—dating from Antyllus, second century A.D. (Castiglioni, 1941)—ligated the main vessel of the aneurysm in the hope that it would clot, but the results were not good. For example, of 60 patients with subclavian aneurysms who were operated upon, 43 died (Poland, 1869); of 20 with innominate aneurysms, 17 died (Erichsen, 1895); and of 18 who had aortic ligations all died (Bigger, 1940). Various other methods were therefore tried (Erichsen, 1895):—

1. The medical treatment of Valsalva, consisting of starvation, dehydration, and exsanguination, "until the patient is so weak he cannot lift himself off the bed".

2. Compression with the fingers or with special clamps.

3. Manipulations to detach clot and so occlude the emerging vessel.

4. Galvano-puncture.

5. Intravascular injections or ergot and other substances.

6. Acupuncture with very fine needles, introduced by Velpeau (1831).

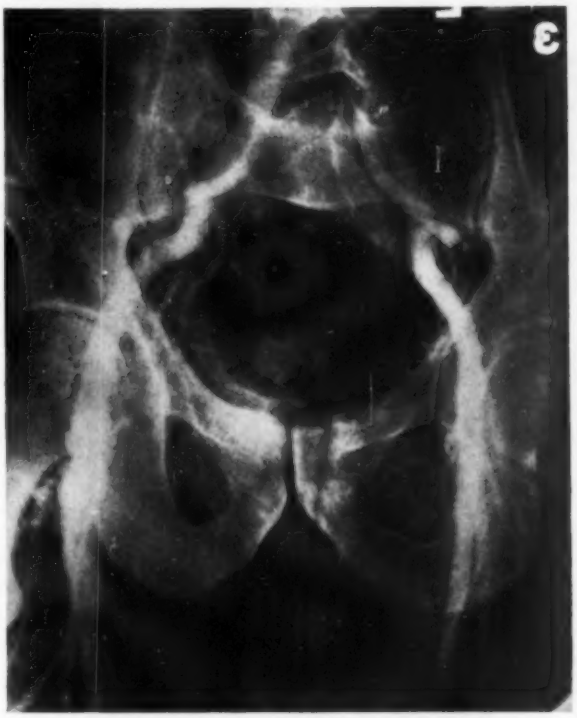


FIG. 513.—Aortogram showing the relatively slight distortion of the main arterial channel of a right femoral aneurysm, which was clinically about 2½ in. long and 2 in. wide. Subsequent rupture causing death.

7. The introduction into the sac of long lengths of catgut, horsehair, or wire (Moore and Murchison, 1864), the latter being sometimes combined with electrolysis. Bryant (1877) put 26 ft. of horsehair into the popliteal aneurysm of a patient dying from ulcerative endocarditis "and thus averted the threatened rupture", prolonging life for a few days.

To-day, however, aneurysms are treated in the following ways:—

Table II.—INCIDENCE OF ANEURYSMS—HOSPITAL ADMISSIONS

SITE	AUTHOR	HOSPITAL	NUMBER OF YEARS RECORDED	NUMBER OF ANEURYSMS
Abdominal aorta	Osler, 1905	Johns Hopkins	16	16
All sites except cerebral	Colt, 1926	St. Bartholomew's	36	130 saccular
Abdominal aorta	Kampmeier, 1936		30	68
Thoracic aorta	Hospital records 1940-1953	Leeds General Infirmary	14	42
Abdominal aorta				17 } 67
Peripheral vessels				8
	MYCOTIC ANEURYSMS			
All sites	Stengel and Wolforth, 1923	Collected from Literature	70	217
All sites	Garland, 1932	Leeds General Infirmary post-mortem records	20	4 out of 12,000 autopsies

1. When repair of the main vessel is impossible because of the site or size of the aneurysm, extension or rupture is prevented in three ways :—

a. By intravascular wiring, using either Colt's umbrella (Colt and Power, 1903), or a long length of wire through which an electric current is passed (Blakemore, 1951), to produce clotting in the sac.

b. By producing a reactive fibrosis round the aneurysm with "polythene cellophane" (Abbot, 1949) or dicetyl phosphate (Berman and Hull, 1952).

FIG. 514.—Arteriogram showing an aneurysm just below the elbow. The radial artery is intact, the ulnar is not filled, and there is retrograde filling of the interosseous artery and aneurysm. Treated by obliterative endo-aneurysmorrhaphy.

c. By ligating all the vessels connected with the aneurysm either from without, usually with excision of the sac; or from within (obliterative endo-aneurysmorrhaphy (Matas, 1888, 1903). The former method is to be avoided as it interferes with the collateral vessels upon which the distal areas depend. The latter is sound in principle and good in practice, for it is easy and does not interfere with collateral vessels. It was used in *Case* 3.

Case 3.—*Obliterative Endo-aneurysmorrhaphy.*

A boy of 11 was admitted with an aneurysm of the proximal third of the left forearm, mainly on its volar aspect, seven weeks after receiving a penetrating wound (*Fig.* 514). The right ulnar and both radial pulses were strong; the left ulnar pulse was absent. The swelling was gradually increasing in size and causing pain.

Clearly excision of an aneurysm in this position, or ligation of the vessels from outside the sac, would have been a difficult and hazardous procedure. The aneurysm was therefore opened, the entering vessels sutured with 5/0 silk, no attempt being made to obliterate the sac, and the skin closed. The operation was very easy.

The boy's post-operative course has been uneventful. 2½ months later the left ulnar pulse has become palpable but is weak.

2. When the main vessel can be reconstituted, two methods are available: (*a*) Reparative endo-aneurysmorrhaphy; (*b*) Grafting.

FIG. 515.—Arteriogram showing an aneurysm at the wrist arising from the radial artery by a narrow neck. The radial artery is in spasm just above the aneurysm. Treated by reconstructive endo-aneurysmorrhaphy.

a. If the aneurysm is saccular and the neck not too wide, the vessel may be freed from the sac and repaired, or else the opening in it may be closed from within the sac, leaving the vessel itself intact and conducting blood (Matas, 1888, 1903). This is the method of choice, and it can be used more widely than is generally supposed (Cooley and de Bakey, 1952) (*Case* 4).

Case 4.—*Reparative Endo-aneurysmorrhaphy.*

A girl aged 23 was admitted in December, 1953, with a pulsating hæmatoma at the wrist from a penetrating wound to the radial artery. This was left for nine days but began to give her pain. An arteriogram (*Fig.* 515) showed the aneurysm to arise from the medial side of the radial artery through a narrow opening. This was therefore exposed, the hole in the artery closed with 5/0 silk, the aneurysm cleared of its contents, and the wound closed. Her post-operative course was uneventful. Six

weeks later the radial artery was pulsating vigorously and equalled that on the other side. She has had no further trouble.

b. Grafting.—The affected segment of artery may be replaced by a tube of plastic or of special cloth (Moore, 1950; Voorhees, Jaretzki, and Blakemore, 1952) or by a graft (*Case* 1). The results with tubes do not justify their use except in a grave emergency and will not be considered further.

(Since writing this paper two additional reports have been published on the use of sewable plastic tubes (nylon and polythene-nylon) for the replacement of blood vessels (Blakemore and others, Shumaker and others). The results, in large vessels at any rate, are excellent).

The immediate results of grafting large vessels are good (Gross, 1951; Dubost, Oeconomos, Durand, and Metianu, 1950; Oudot, 1951; Brock, 1953), but the final results will not be known for years to come. The use of grafts is justified because the prognosis is otherwise so bad, and, as far as can be seen at present, is the method of choice after reconstructive endo-aneurysmorrhaphy. The graft may be either a vein from the patient or an artery from another human; it must therefore be preserved for varying periods. Vessels from other species are unsuitable.

Venous autografts have been used for nearly fifty years (Carrel, 1910; Pringle, 1913; Blakemore, 1947) and serve well to replace smaller vessels, for which this is probably the method of choice (Cooke, Hughes, Jahnke, and Seeley, 1953). With the aorta the position is not so happy; firstly because it means ligating the inferior vena cava with its attendant disabilities, and secondly because replacement of the aorta by a vein has not proved very satisfactory (Schmitz, Kanar, Sauvage, Storer, and Harkins, 1953; Johnson, Kirkby, and Hardy, 1953).

If arteries are to be used as grafts they are taken with sterile precautions within four hours of death from young and healthy bodies. Deterling, Pashley, and Blunt (1953), and Brown, Hufnagel, Pate, and Strong (1953), have recently shown, however, that the vessels can be taken up to 36 hours after death if the body is promptly cooled; the state of the vessels on inspection is of more importance than the age of the patient from whom they come. Nevertheless, it seems wise to take the graft as soon as possible after death from young and healthy bodies.

The grafts are then preserved in four ways:—

1. In an isotonic solution such as that recommended by Gross, Hurwith, Bill, and Peirce (1948) or in Ringer's solution with plasma added (Swan, Robertson, and Johnson, 1950; Swann and Morfit, 1951), kept above freezing point but below 8° C.

2. By rapidly freezing the graft with carbon-dioxide snow in alcohol, or with liquid nitrogen (Blakemore and Lord, 1945; Deterling, Coleman, and Pashley, 1951; Hufnagel and Eastcott, 1952), and storing at a temperature of − 70° C.

3. By using formalin or alcohol as a preservative (Guthrie, 1919; Peirce, Rheinlander, Mortiz, Gross, and Merril, 1949; Van Weel, 1953; R. P. di Valmaggiore and Tossati, 1950; Nuboer, 1953). The method has the great advantage that the vessels need not be sterile when put into the preservative.

4. By freeze-drying the graft (Marangoni and Cecchini, 1951; Gentsch, Waters, and Glenn, 1954; Brown and others, 1953).

Of the four methods, the results with freeze-drying are good (Brown and others, 1953), but this is not yet widely used; the preparation of the graft for storage is complicated. Storage in formalin or alcohol is undoubtedly the easiest and the few published results seem satisfactory. The remaining two methods both give good results; the reports of storage in an isotonic solution at 1–8° C. seem better than those of frozen grafts (Gross, Bill, and Peirce, 1949; Peirce, 1952) and the method is much simpler. The one alleged drawback—the short time for which the graft can be kept—has been shown to be a myth (Swan and others, 1950; Deterling and others, 1953). This method was therefore used in *Case* 1.

SUMMARY

1. The resection and grafting of the aortic bifurcation for a mycotic aneurysm of the left common iliac artery is described. The graft used was arterial and had been stored in ' Gross's balanced salt solution ' at 1–8° C.

2. Such operations are justified because of the poor prognosis in patients with aneurysms.

3. The average survival of a patient with an aneurysm is about eighteen months; with a mycotic aneurysm the outlook is probably worse. Too few examples have been described since the introduction of antibiotics to be dogmatic on this point.

4. Some patients will cure their aneurysms spontaneously and some will live for many years without disaster, but which, one cannot tell.

5. No surgeon, apart from warfare, is likely to see many aneurysms—the collected figures of admissions and post-mortem records from various sources make this clear.

6. The possible methods of treatment are briefly described and illustrated by four case reports.

7. A brief description and assessment of the various methods of storing vascular grafts is given.

We would like to thank Professor P. J. Moir for permission to include *Case* 2, and especially for allowing H. D. M. the use of his beds. *Cases* 3 and 4 were referred by Mr. M. Ellis.

We are grateful to the Staff of the General Infirmary at Leeds for access to their records.

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SURGICAL BIOPSIES AND NEOPLASTIC DISEASE

A REVIEW OF TWENTY YEARS' PRACTICE AND FIFTY-EIGHT THOUSAND SPECIMENS

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THE Department of Pathology of the Queen's University of Belfast has for many years served the teaching hospitals and the consultants of the area by undertaking the pathological study of specimens removed at operation in both hospital and private practice. The study of such material is an essential part of the training of professional staff working in a university department, while the tending of careful and considered reports is one of the most valuable contributions a medical school can make to the maintenance and advancement of the standards of practice in its area. For the twenty years ending 1952 a convenient system of records has been in existence and a complete histological examination has been made of all specimens submitted. As part of another study it was necessary to arrange and collate this material. Some observations, especially as they relate to tumours, have seemed of some general interest, especially since it has been possible to contrast them with observations made on 8000 autopsies studied in the same department.

It is proper to emphasize the serious limitations imposed in any survey of biopsy material. In no way do these specimens reflect the total, or even relative, incidence of surgical disease in a community. They are largely a measure of the surgical interest in certain organs, and, perhaps less directly, of surgical success in curative or palliative procedures. The figures are an index of morbidity rather than mortality. They are most likely to interest surgeons and those responsible for the provision of hospital facilities. This divergence from mortality data can be shown in this series by a comparison with hospital autopsy data. Here again selection operates,

and, indeed, the truth concerning the relative or absolute incidence of disease cannot be determined from any existing data—surgical, post-mortem, or clinical.

It is not possible to claim that the specimens submitted were unselected. Especially in the early days some surgeons failed to avail themselves of the service, and specimens of appendices and of tonsils have never been submitted in numbers at all comparable to those excised. The proportion between the major surgical conditions is likely to be more accurately measured than their absolute incidence in general surgical practice. It can be claimed only that the material is unselected in that both general and special hospitals and private practice have contributed to it and that all these sources serve a roughly similar population area and are a fair cross-section of the illnesses, especially the major surgical illnesses, of a modern community. Changes in the incidence over the twenty-year period will be discussed, and attributed to changing trends in surgery and in the demands for surgery and not to any changes in the incidence of disease.

SOURCES OF MATERIAL AND METHODS OF INDEXING

Of the total of 58,347 biopsies, 40,656 came from the Royal Victoria Hospital and from the general and special hospitals sharing its laboratory services. The remainder came from the Belfast City Hospital, the Mater Infirmorum Hospital, the Samaritan Hospital for Women, and from private patients in the Musgrave and Clark Clinics and in nursing homes. For various reasons it is only useful to include specimens from the Royal Victoria Hospital and the hospitals sharing its laboratory facilities in any comparison of yearly or five-yearly trends, but these are fully representative of all divisions of surgical and medical practice.

Records from different laboratories differ in what is recorded as a single specimen. Here all material excised at one operation from one patient is counted as one biopsy specimen provided it shows a single disease process. Thus a breast or stomach is one specimen, and whether the related lymph-glands show secondary tumour deposits or not they are not separated as another specimen. Significant disease may be present in only one component of an operative specimen such as a uterus and its adnexæ, and then only the diagnosis for the organ affected is listed. If, however, both uterine scrapings and tissue from the cervix are submitted from the same patient they must be regarded as separate specimens whether they show disease or not, since they cannot both have been expected to show the same disease process. If separate and significant pathological conditions are present, for example, in an ovary submitted along with a diseased uterus, two or more separate biopsy diagnoses must be listed. An absence of disease in the material submitted is listed as 'normal' and the inability of the pathologist to make a diagnosis from it as 'no diagnosis'. These diagnoses were made in 3·0 per cent and in 2·2 per cent of the total examinations, and, in addition, in over 7500 endometrial scrapings (13 per cent of all biopsies) the appearances were described according to the period of the cycle. It has been found that for every 100 biopsy diagnoses made the excised tissue received came from only 85 operations. This disparity between the number of operative and pathological specimens is a serious difficulty in the comparison of reports from different laboratories. Some laboratories separate every specimen received into many component parts, making, for example, as many as six specimens out of each uterus and adnexæ. The real value of this is doubtful, but the resultant large figures may gratify committees and administrators.

In any survey of biopsy specimens a serious limitation is multiple biopsies of the same condition from the same patient. This gives an erroneously high incidence for such conditions as carcinoma of the body of the uterus, where uterine scrapings usually provide the diagnosis which is later confirmed by examination of the excised uterus. Excision of the rectum for carcinoma is much less often dependent on an earlier biopsy, and a relatively small number of carcinomas of the cervix uteri appear to have been treated by excision after a diagnostic biopsy. However, in almost all other organs and disease conditions the total number of biopsy diagnoses made corresponds to the total number of lesions found in patients submitted to surgery.

Since 1937, 8000 autopsies from the teaching hospitals of this medical school have been performed and histological sections have been prepared and studied from all organs. These autopsies included 5437 on patients over the age of 15 years, 850 on children between the age of 1 month and 15 years, and the remainder were on stillborn and newborn infants. Like all hospital autopsies these are to some extent selected, but they are from a population similar to the biopsies and provide an interesting contrast.

SITES OF BIOPSY

This is an index of surgical or medical interest and is dictated in part by ease of access. Thus the large number of specimens of skin reflect the interest of the skin department and the convenience of skin biopsy, and 73 per cent of the specimens from the body of the uterus were endometrial scrapings. The incidence for different organs and tissues is shown in *Table I*.

Table I.—Percentage Distribution of 58,347 Biopsies

Uterus: Corpus	26·9	Skin and Subcutaneous Tissue	10·7
Cervix	10·3	Breast	6·6
Ovary	6·2	Lymph-glands	4·1
Fallopian tubes	1·5	Prostate	3·6
Vulva and Vagina	1·0	Thyroid	2·9
Fœtus and/or Placenta	0·4		
Total of Gynæcological Specimens	46·3		

Over 1 per cent	Gall-bladder 2·4, appendix 1·8, rectum 1·7, kidney 1·6, large intestine 1·3, bronchi and lungs 1·2, mouth 1·1, omentum and peritoneum 1·0, bone 1·0.
Over 0·5 per cent	Eye and orbit 0·7, urinary bladder 0·6, brain 0·6, œsophagus 0·6, joints, bursæ, and synovial membranes 0·6, pharynx and tonsils 0·5, testes 0·5, larynx and epiglottis 0·5, salivary glands 0·5, lips 0·5, nasal passages 0·5.
Under 0·5 per cent	Nerves 0·4, tongue 0·4, liver 0·4, small intestine 0·3, ear 0·3, muscle 0·3, penis 0·2, blood-vessels 0·2, spleen 0·2, urethra 0·2, spinal cord and membranes 0·1.

MALIGNANT TUMOURS

Including 221 primary tumours of the brain, spinal cord and membranes as malignant, there were 11,242 examples of malignancy in the total of 58,347 biopsies (that is 19·3 per cent).

Though it is irrelevant to the distribution of malignancy between different organs it is of some interest to surgeons to know what percentage of

Table II.—Percentage Malignancy in Biopsies from Different Sites

Over 50 per cent	Œsophagus 80, colon 73, rectum 57, brain, spinal cord and membranes 52, larynx and epiglottis 51, lips 50.
Over 25 per cent	Omentum 47, breast 45, penis 45, lymph-glands 42, ear 42, urinary bladder 38, bronchi and lungs 37, skin and subcutaneous tissue 35, liver 35, tongue 34, stomach 33, vagina 32, vulva 28, eye and orbit 30, bones 28, pancreas 27, pharynx and tonsils 25.
Over 10 per cent	Mouth (excluding tongue) 20, small intestine 19, testes 19, uterus, cervix 12.
Under 10 per cent (more important organs only)	Salivary glands 9, uterus, corpus 3, thyroid 3.

biopsies from an organ were malignant. This will vary with individual differences in surgical practice, but figures such as are given in *Table II* are useful as a rough index.

More important than the probable incidence of malignancy in biopsies taken from individual organs is the proportion of total malignancies attributable to each organ. In biopsy analysis the primary site of malignancy is not always certain and all growths in the omentum, and in the present series 70 per cent of those in lymph-glands, should properly be assigned elsewhere. Some growths assigned to the eye and orbital tissues, the ear, and the penis, could be regarded as arising in skin. The organs and tissues in which malignancy is most often discovered or confirmed by surgical exploration are given in *Table III*.

The non-epithelial malignant tumours represent only 7·2 per cent of all the malignant growths. In bone and lymph-node biopsies they occurred in

Table III.—Distribution of 11,242 Surgical Malignancies
(Expressed as percentage of Total)

Over 2·5 per cent of Total	Skin 19·9, breast 16·0, lymph-glands 9·3, uterus, cervix 7·0, rectum 5·3, colon 5·0, uterus, corpus 4·1, stomach 3·3, ovaries 2·5, omentum 2·5, œsophagus 2·5, bronchi and lungs 2·5.
Over 1·0 per cent of Total	Mouth and tongue 1·9, brain, cord, and membranes 1·9, prostate 1·7, bones 1·4, larynx and epiglottis 1·4, lips 1·2, urinary bladder 1·2.
Under 1·0 per cent of Total	Vulva 0·9, peripheral nerves 0·7, pharynx and larynx 0·7, vagina 0·6, liver 0·6, ear 0·6, testes 0·5, penis 0·5, gall-bladder 0·4.

20·4 and 12·5 per cent of all biopsies and constitute 75 and 30 per cent of the malignant growths represented otherwise by secondary carcinomatous deposits. Apart from these sites and the body of the uterus, where they represent 8 per cent of all malignant growths, they assume little numerical significance elsewhere. In the small intestine they are nearly as frequent as epithelial growths (11 to 18 examples), but both are rare.

Comparison with Malignant Growths found at Autopsies.—In 8000 autopsies 1178 malignant tumours (14·7 per cent) were discovered. The biopsy specimens received from children are relatively few and their inclusion or elimination makes no significant difference to the incidence and distribution of malignancy. The incidence of malignancy revealed by autopsy is more adequately expressed if only the 1124 cancers encountered in the 5437 autopsies over the age of 15 years are considered (20·7 per cent). Almost all these tumours were directly responsible for death except those occurring in the prostate and skin, which were often only incidental. The percentage of total malignancies assigned to each organ is given in *Table IV*. Despite the coincidence that roughly one in every five biopsies or autopsies reveals malignancy the incidence in the different organs varies greatly in the two series. The difference can be related largely to the small percentage of the total neoplasms of the lung, stomach, brain, prostate, and pancreas submitted to biopsy diagnosis or surgical treatment as compared to the very large proportion of skin, breast, and uterine growths observed and submitted to such surgery. The relatively small number of tumours of the skin, breast, and uterus in the autopsy series is not necessarily due to their almost total elimination

Table IV.—Percentage Distribution of 1124 Malignancies found in 5437 Adult Autopsies

Lung	15·8	Kidney	3·0
Stomach	12·2	Urinary bladder	3·0
Brain	11·4	Bile-ducts and Gall-bladder	2·4
Large intestine	11·3	Liver	2·0
Prostate	8·3	Ovary	1·5
Hæmopoietic and Lymphoid tissue	7·3	Uterus	1·5
Breast	6·3	Skin	1·0
Pancreas	4·6	Bone	0·9
Œsophagus	4·0		

by surgery. It can only be stated that, whether patients with these tumours die from spread of their growth or from entirely different conditions, few of them die in hospital.

BENIGN TUMOURS AND CYSTS

Benign tumours, cysts, and localized tissue malformations have a total incidence very close to that of malignant tumours, with 11,969 examples in 58,347 biosies (20 per cent). Their distribution is, however, very different. In certain organs they are very frequent; thus in ovaries which can arbitrarily be regarded in some way as abnormal they account

Table V.—Percentage Distribution of 11,969 Benign Tumours and Cysts

Uterus: corpus	26·5	Mouth	2·3
Ovaries	23·5	Salivary glands	1·8
Skin	18·0	Bone	1·6
Thyroid	7·0	Vulva	1·2
Breast	6·8	Urinary bladder	1·0

for 78 per cent of all abnormalities, and in salivary glands they are present in 69 per cent of those excised. In the thyroid the recognition of adenomas is admittedly arbitrary, but they have been listed in 47 per cent of the specimens examined. Simple tumours and cysts are frequent in biopsies of the mouth (44 per cent), skin (33), vulva (31), tongue (29),

lips (29), nasal passages (29), urinary bladder (28) and bones (25), and assume considerable importance in the breast (19), uterus (19), and rectum (18). They are uncommon in the lungs (3), kidney (2), stomach (1), and cervix uteri (1).

The largest number of benign tumours or cysts occur in the body of the uterus and almost exactly three-quarters are fibromyomas and slightly more than half the remainder are adenomyomatous tumours. Their distribution between the various organs is listed in *Table V*.

Excluding 257 simple nævi of the skin, 562 fibro-adenomas of the breast, and 477 adenomyomas of the uterus, there were 3829 benign tumours of mesenchymal origin (32 per cent). Almost 60 per cent of these arose in the body or neck of the uterus.

CHANGING INCIDENCE OF MALIGNANCY

If the twenty-year period is divided into four periods of five years each, sufficient numbers of most neoplastic conditions are included to indicate significant changes in their incidence. It will be appreciated that the development of the hospital services, with an increase in the amount of surgery undertaken and, perhaps, a growing awareness of the value and importance of pathological examination, has greatly increased the number of specimens submitted for examination. It is of interest to inquire how far this has increased the number of malignant conditions discovered and how far this increase affects organs in which biopsy incidence is low relative to autopsy incidence.

If the total biopsies analysed are represented by 100 the percentage in each of the four five-year periods is 8·4, 11·5, 34·6, and 45·5. It may be convenient to think of these as the ratios 3 : 4 : 12 : 16. Those conditions the incidence of which has increased at this rate or faster are either increasing in incidence or are the object of increasing surgical interest. It may also sometimes be useful to compare changes in the incidence of malignant tumours with the incidence of total or non-neoplastic biopsies from an organ. In general, malignant conditions have not increased as rapidly as more trivial conditions. Certain conditions, where the survey has shown that the biopsy incidence is low compared to the apparent importance of the condition in autopsies, show a rising incidence which is properly explained by the increasing surgical interest. Thus carcinoma of the bronchus showed a sharply rising biopsy incidence in the four five-year periods, with a percentage distribution of 2, 8, 16, and 74 per cent, and in carcinoma of the œsophagus the rise in incidence corresponded closely to the general increase in total biopsies and was 9, 18, 26, and 47. Carcinomas of the stomach (12, 12, 20, 54), of the colon (12, 18, 23, 45) and rectum (11, 15, 20, 53) showed similar but less marked trends. The rising incidence of such accessible growths as carcinoma of the lip (4, 9, 24, 60) and mouth (9, 10, 12, 67) appears inadequately explained unless some were treated by radiotherapy in the past without histological confirmation. Many skin tumours were treated here without histological study in the past and the apparently disproportionate rise in all skin tumours (6, 14, 16, 65) is not disproportionate when related to the rise in other non-neoplastic conditions of the skin. This rise is due to the great interest taken by the departments of dermatology in pathological study.

Some conditions have failed to increase at a rate comparable to the general biopsy population or even to the number of biopsies taken from the organ concerned. Thus carcinoma of the cervix uteri has a percentage distribution of 21, 20, 28, 30 in the four five-year periods, and in contrast biopsies revealing chronic cervicitis have increased rapidly (10, 11, 15, 62). Similarly Hodgkin's disease (26, 18, 18, 37) and renal hypernephroma (14, 20, 23, 31) have increased proportionately little. Perhaps in these conditions we are approaching ascertainment of all cases. The number of cases of breast carcinoma (13, 20, 26, 40) and of carcinoma of the body of the uterus (15, 14, 28, 43) is not yet stationary and all cases are probably not yet treated.

SUMMARY

Neither biopsy nor autopsy or clinical study can give a true measure of the incidence of malignancy or its distribution as between different organs. A survey of over 58,000 surgical biopsies showed an incidence of malignant growth of 19·3 per cent, and there was a predominance of malignant growth in the skin, breast, large bowel and rectum, lymph-glands, and cervix uteri. In 5437 hospital autopsies in adults the incidence was 20·7 per cent and the organs most commonly affected were the lung, stomach, brain, and large intestine and rectum.

A study of the material of the past twenty years in five-year periods shows that biopsies from almost all organs have increased at least three or four times. In some organs where the autopsy incidence of malignant growth is high relative to that in the biopsy series, such as the bronchi, œsophagus, and stomach, the increasing incidence of biopsy examination has been paralleled by the increase in the biopsy diagnosis of malignancy. In some conditions, such as carcinoma of the cervix uteri, Hodgkin's disease, and renal hypernephroma ascertainment of cases has always been fairly complete and the increase has been slight. The number of patients with cancer of the breast and body of the uterus submitting themselves for diagnosis and treatment is apparently not yet stationary.

I wish to thank Professor Biggart for his interest and for allowing this use of departmental records; my secretary, Mrs. Price, for her careful record keeping; and the Northern Ireland Hospitals Authority for a grant for secretarial assistance in this and other work.

EXPERIMENTAL SURGERY

THE HISTOLOGICAL APPEARANCES OF SOME NORMAL TISSUES AT LOW TEMPERATURES

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THE preservation of tissues at low temperatures for surgical purposes has aroused increasing interest in the effects of very low temperatures on cell survival, yet few attempts have been made to study histological appearances under such conditions. These differ greatly from the findings after thawing and fixation at room temperature, and this article describes a method for fixing tissues at low temperatures, points out the use of freeze-drying of tissue for the same purpose, and, lastly, gives an account of the appearances of some normal tissues from the rat examined in these ways after slow freezing.

METHODS

Pieces of fresh rat tissue, 1 mm. thick and up to 3 mm. across, were placed individually on small copper-foil angles and dropped with labels into dry test-tubes with rubber caps. The test-tubes were suspended in a wire-gauze bucket in a Dewar flask (1 litre) containing industrial spirit. The stem of a rotary stirrer passed through the centre of the bucket to a propellor beneath and the alcohol was agitated continuously. Finely powdered CO_2-snow was added slowly to the alcohol to lower the temperature, and a controlled rate of 1° C./2 minutes from + 4° to − 75° C. was adopted to obtain marked crystal formation. The temperature was lowered quickly to + 4° C., but below − 75° C. the cooling rate was very slow. The process thus took nearly three hours to perform, at the end of which time absolute alcohol at − 79° C. was added to the specimens and the copper angles were detached from the frozen tissue samples by light taps with a spatula. The material was fixed while stored at − 79° C. for periods of 14 to 21 days. The quality of the fixation was improved by stirring the cold alcohol with a rotating rod for several hours at a time, or, latterly, continuously night and day, while the temperature was maintained at − 79° C.

At the end of the fixation period the test-tubes were allowed to warm up at room temperature for about 30 minutes and after three changes of absolute alcohol (each 30 minutes) cleared in cedarwood oil and cut in paraffin wax. Sections were stained with hæmatoxylin and eosin (and some by Van Gieson's stain).

Other tissue was fixed in absolute alcohol at + 4° C. and − 4° to − 6° C. in a refrigerator, and at − 26° C. in an ice-cream refrigerator after slow freezing to those temperatures only.

Tissue was dried in the frozen state in an Edwards's tissue dryer (TD4), at approximately − 40° C. and at a vacuum of approximately 0·005 mm. Hg for three or four days. The dry tissue was embedded in wax directly or, more commonly, fixed in absolute alcohol for 4 hours before clearing and embedding (Emmel, 1946).

RESULTS

Slow freezing produces remarkable alterations in the histological appearances of fresh normal rat tissues. It is often impossible to recognize the nature of the tissue, and the distortion is due to the formation of enormous numbers of large ice crystals, distributed at random in soft tissue such as the liver and spleen, but orientated along tissue planes in voluntary muscle and fibrous tissue.

The *liver* (*Figs.* 516, 517) contained ice-crystal spaces ranging in size from 9 × 4μ to 37 × 26 μ. The largest spaces may have contained more than one medium-sized crystal. Some were distinctly rod-shaped, with rounded or partly flattened ends. The distortion of the tissue was so great that it was not until liver fixed at higher temperatures was examined (− 4° to − 6° C. and − 26° C., after slow freezing to these temperatures) that it was realized that many of the large rod-shaped ice-crystal spaces were inside distended nuclei. At − 4° C. to − 6° C. (*Fig.* 518) the first small nuclear spaces had appeared, while at − 26° C. (*Fig.* 519) far more, larger, ice-crystal spaces were seen. Re-examination of the − 79° C. preparation revealed that many of the rod-shaped spaces were surrounded by a thin dark margin of chromatin. The shrunken, partly dehydrated, cytoplasm was stretched around the ice-crystals and here and there one could make out a shrunken liver-cell nucleus which had escaped ice-crystal distension. The positions of the portal tracts and intralobular veins could be identified more easily in Van Gieson preparations.

To obtain a rough estimate of the relative volumes of large ice-spaces to partly dehydrated tissue, a print of *Fig.* 517 was cut up to separate ice-spaces and tissue, and the two quantities weighed. Results suggested that at − 79° C. about 50 per cent by volume of the liver was in the form of large ice-crystals. Considerable concentration of cytoplasm must have occurred and in view of the increase in crystal size down to −. 79° C. it is possible that slow freezing to a lower temperature may well increase this percentage by further crystal growth.

Heart muscle of the left ventricle (*Fig.* 520) contained very large oval ice-crystal spaces, maximum diameter 85μ, but the largest of these probably represented several crystals not as well outlined by cytoplasm as in the liver. The cytoplasm of the muscle-fibres was condensed and stained deeply with eosin; it was somewhat refractile, but no striations

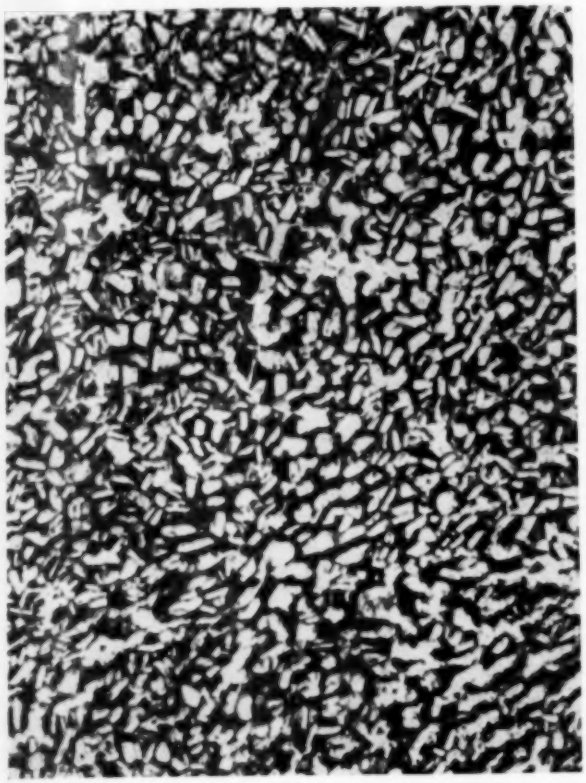

FIG. 516.—Liver fixed at − 79° C. after slow freezing. Nuclear and extranuclear ice-crystal spaces are seen. (× 140.)

FIG. 517.—Higher magnification of material in previous figure. The thin chromatin margins around the rod-shaped intranuclear ice-crystal spaces are shown. (× 600.)

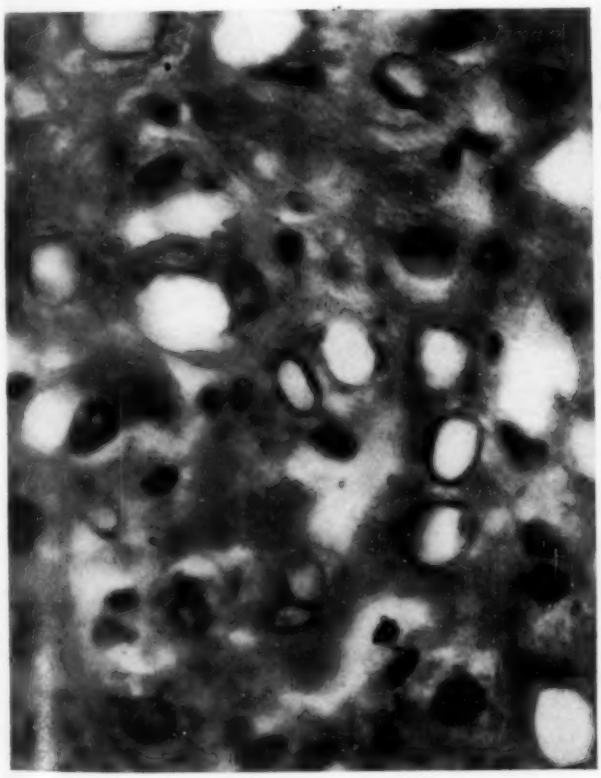

FIG. 518.—Liver fixed at − 4° to 6° C. The scattered nuclear ice-crystal spaces have distinct chromatin margins. (× 600.)

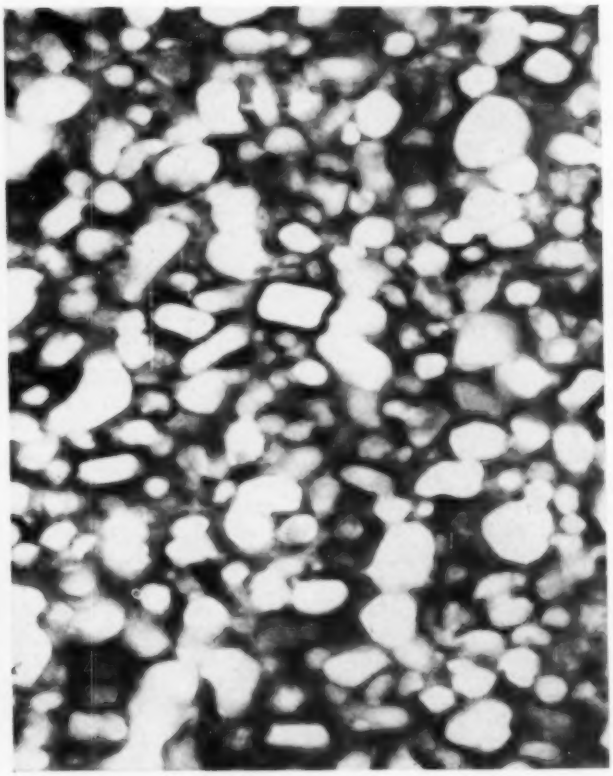

FIG. 519.—Liver fixed at − 26° C. after slow freezing. Ice-crystal spaces are more numerous but not as large as those in *Fig.* 517. (× 600.)

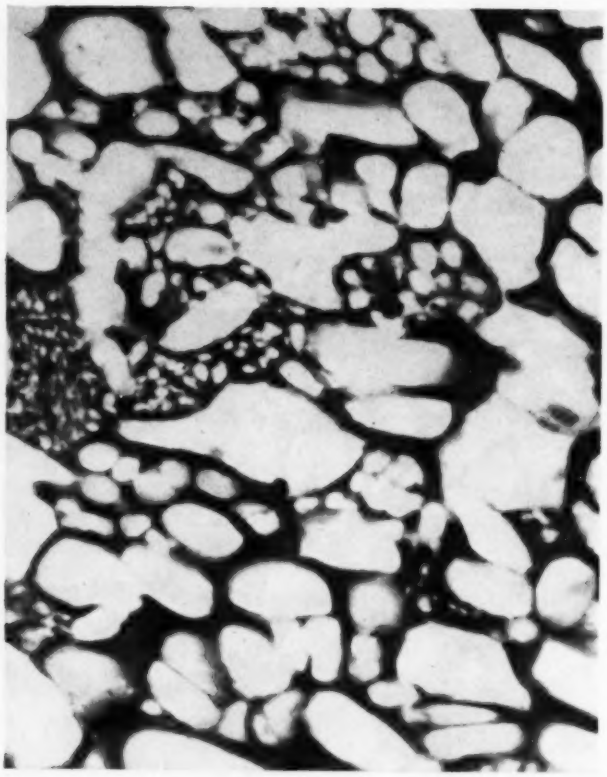

FIG. 520.—Myocardium fixed at — 79° C. after slow freezing. (× 600.)

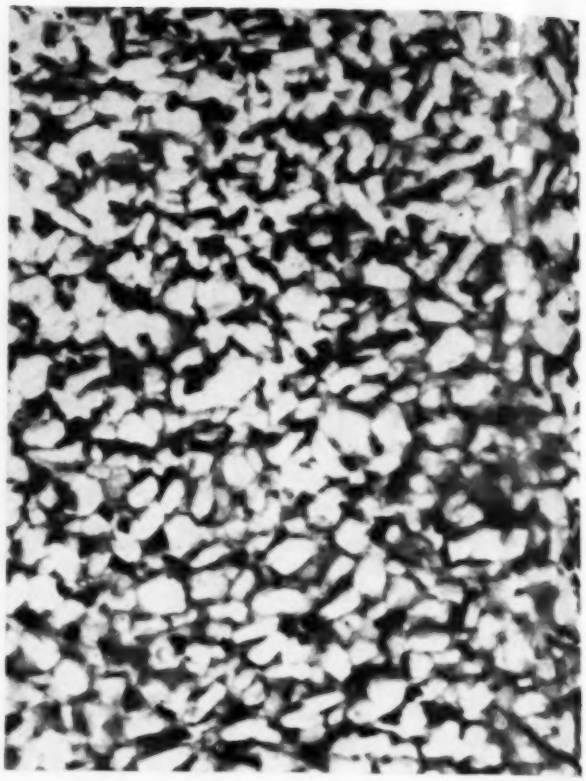

FIG. 521.—Spleen fixed at — 79° C. after slow freezing. The Malpighian body lies in the upper half of the field. (× 350.)

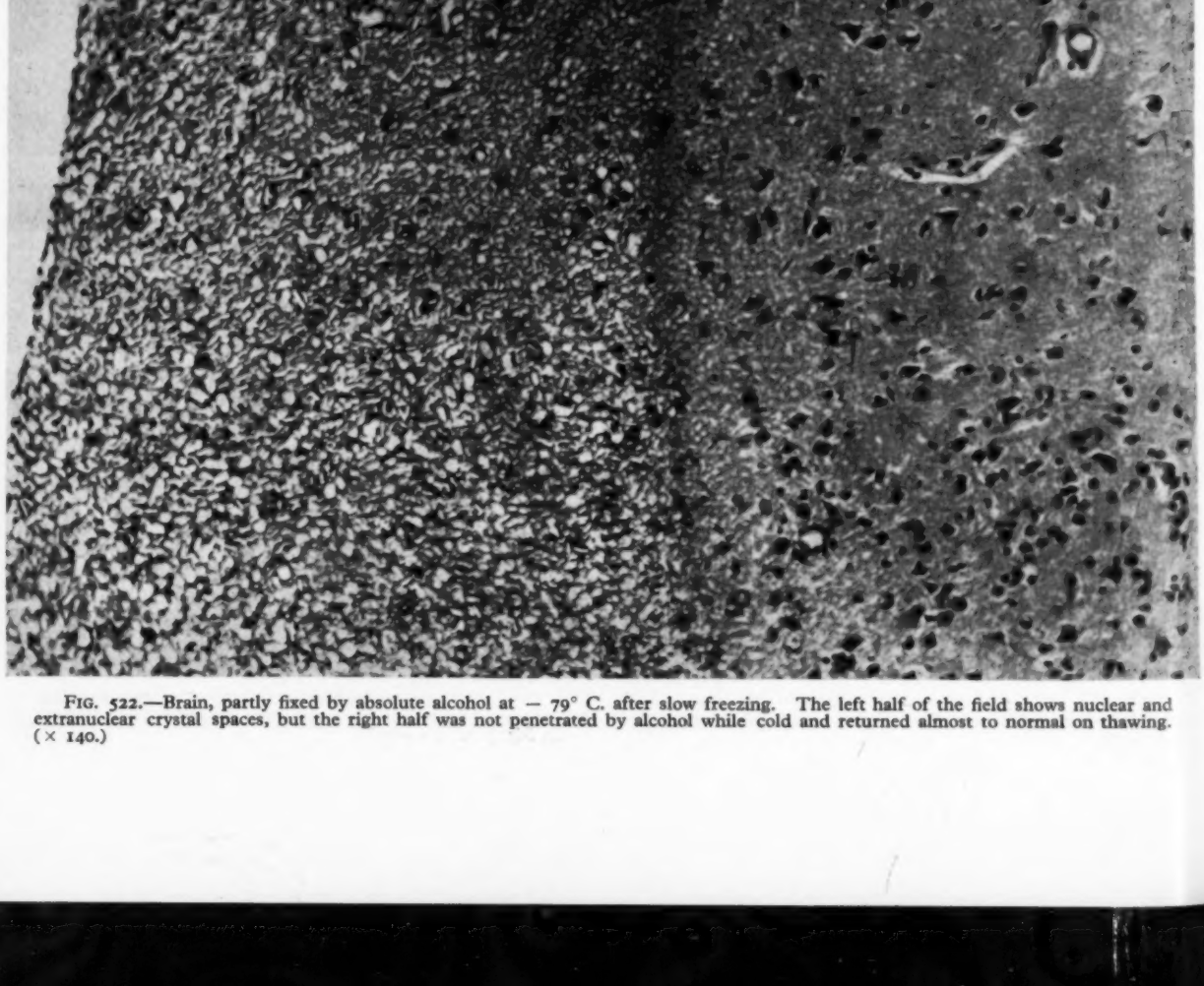

FIG. 522.—Brain, partly fixed by absolute alcohol at — 79° C. after slow freezing. The left half of the field shows nuclear and extranuclear crystal spaces, but the right half was not penetrated by alcohol while cold and returned almost to normal on thawing. (× 140.)

were visible. The nuclei showed two forms of change corresponding to cytoplasmic differences. Usually they were shrunken, not crystallized, and moulded between the extranuclear ice-crystal spaces, but scattered through the sections were small islands of paler staining muscle-fibres containing numerous fine, round, or oval, ice-crystal spaces about 4μ in maximum diameter, and the nuclei of these fibres were crystallized and appeared hollow. It seems possible that the association of nuclear and cytoplasmic vacuolation indicates a different reaction to freezing on the part of different fibres.

The *aorta* was more easily recognizable than the preceding structures. The endothelium was raised by crystal spaces in the subendothelial tissues and some of the endothelial cells showed nuclear crystallization. In the media there were small ice-crystal spaces between the laminæ of elastic and most of the smooth muscle cells showed nuclear crystallization. The adventitia was grossly affected as in other arteries.

Other blood-vessels in the lung and elsewhere showed numerous large ice-crystal spaces in the media, and the intimal and adventitial changes resembled those of the aorta.

Lung architecture was very distorted and in the alveolar walls and bronchial mucosa some nuclei were crystallized and others shrunken. The mucosa was almost unrecognizable, for large oval crystals appeared to occupy far more space in the section than cell protoplasm.

The epithelium of the *œsophagus* was shrunken and there was widening of the intercellular spaces with stretching of the intercellular bridges. A large proportion of the more superficial stratified cells showed nuclear ice-crystal spaces; but some of the crystals seemed to lie outside the nuclei; the maximum diameter of the largest of these was 22μ. The subepidermal connective tissue was riddled with ovoid spaces up to 23μ long, and there was some tendency for orientation parallel to the epithelium. Some fibrocytes and many *smooth-muscle* cells showed nuclear ice-crystal spaces and the cytoplasm of the smooth muscle-fibres was shrunken and shaped between enormous numbers of oval spaces up to 47μ long orientated along these fibres. It was not possible to be sure if some of these ice-crystal spaces were within the cells themselves.

Preparations of the distal half of the *stomach* showed the smooth muscle changes described in the previous paragraph, together with nuclear and extranuclear crystal spaces in all parts of the mucosa and submucosa. A proportion of the oxyntic-cell nuclei was not crystallized but the nuclei of most of the basal chief cells contained multiple, small, round ice-crystal spaces. In all parts of the mucosa were large spherical or oval spaces up to 47μ maximum diameter.

The *small intestine* was intensely crystallized and careful examination revealed some non-crystallized nuclei in the cytoplasm stretched between enormous numbers of nuclear and extranuclear ice-crystal spaces. The *large intestine* was similar in appearance and in both cases the smooth muscle resembled that of the œsophagus.

Fæces were examined to see the state of organisms at low temperatures. The fæcal material was filled with ice-crystal spaces, but in the condensed intercrystalline material the majority of organisms showed no obvious morphological change. Some minute vacuolated objects may have been cysts, but the possibility of ice-crystals within organisms cannot be excluded.

Blood in the lumen of the aorta showed large ice-crystal spaces up to 76μ maximum diameter among the sedimented red cells, but in the plasma there were many small round spaces; the nuclei of the leucocytes were either shrunken and distorted or stretched out by rod-shaped nuclear ice-crystal spaces. The red cells were shrunken together and their outlines were indistinct.

In the *spleen* (*Fig.* 521) the general pattern of ice-crystal spaces was similar to that in the liver, but those in the malpighian bodies were smaller, 32μ maximum diameter, as compared with 38μ in the pulp. Nuclear crystals were seen in some cells of both zones, but most lymphocytes showed no obvious crystalline changes.

The *thymus* was similar to the spleen.

In a mixed *salivary gland* the serous acini showed very fine or moderately fine vacuolation of cytoplasm and some nuclei, but there was considerable crystallization in the basophilic mucous acini, nuclei being crystallized or shrunken.

The *adrenal cortex* also contained a large number of ice-crystal spaces, often rod-shaped like those in the liver but many of the nuclei appeared normal. Rod-shaped nuclear crystals were very prominent in parts. The medulla was similarly affected.

The *kidney* required the full period of fixation described above before the crystal patterns could be appreciated correctly. The glomerular tufts contained numerous round or oval ice-crystal spaces and in the surrounding cytoplasm were nuclei which were sometimes crystallized and sometimes shrunken. The cytoplasm of the tubular cells was distorted by ice-crystal spaces which were similar in shape to those in the liver but not as large (23μ maximum diameter). As in the liver, some tubular nuclei were distorted by large rod-shaped crystals, some were normal, and some shrunken. Some convoluted tubules were shrunken and the cytoplasm and nuclei not crystallized; most other varieties of tubule were crystallized. There is a possibility that the shrunken uncrystallized tubules were incompletely fixed at -79° C.

In the *testis* most of the nuclei of the tubules were crystallized but the spermatozoa appeared uncrystallized and lay, often distorted, between large ice-crystal spaces.

Most of the nuclei of the *ovary* were crystallized, namely, stromal cells, granulosa cells, and cells of blood-vessels (*Fig.* 523). Specimens fixed for short periods showed less crystallization, so that here and with other organs the degree of tissue distortion must be considered along with the quality of fixation.

The *breast*, fixed at -79° C. differed from controls principally in crystallization of the fibrous stroma. The epithelium of the ducts and acini showed vacuolation in the controls but in frozen-fixed material a proportion of the nuclei showed crystallization while the rest were shrunken.

Partial penetration of the *cerebral cortex* by alcohol at -79° C. is illustrated in *Fig.* 522

A comparison can be made between tissue fixed in absolute alcohol in the frozen state and that at room temperature after thawing. In the frozen-fixed part the nerve-cells and intervening fibres are distorted by many oval or rod-shaped ice-crystal spaces and the majority of the nuclei are crystallized. Chromatin margins about the nuclear crystals are more clearly seen against the lightly-stained surrounding tissues than was noted in the liver. Often more than one rod-shaped space was present in one nucleus. In the thawed part of the material fixed by alcohol at room temperature, there were no signs of previous crystallization, and the tissue could not be recognized as having been subjected to slow freezing and moderately slow thawing.

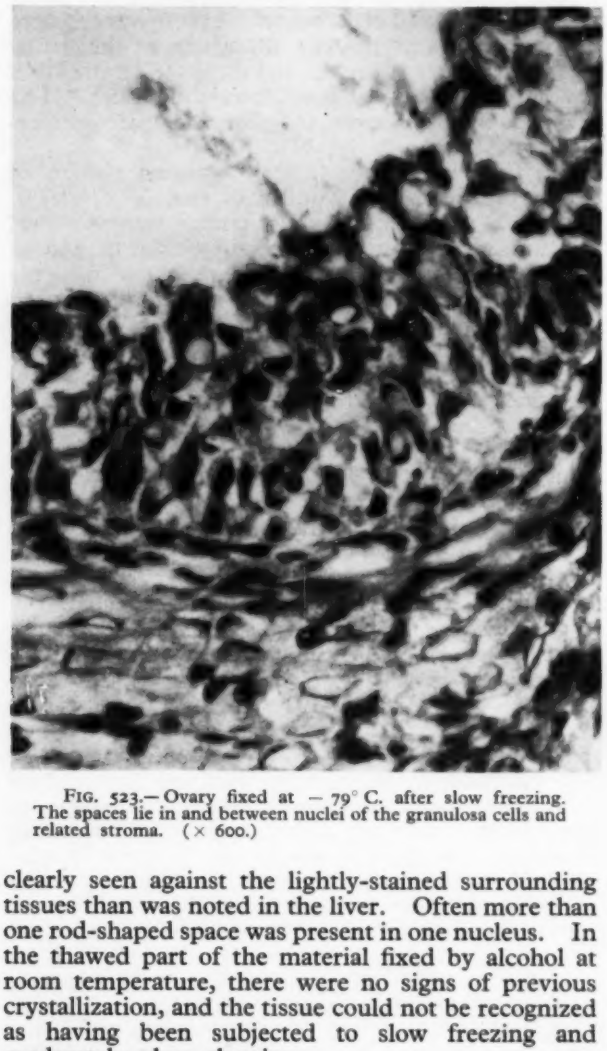

FIG. 523.—Ovary fixed at — 79° C. after slow freezing. The spaces lie in and between nuclei of the granulosa cells and related stroma. (× 600.)

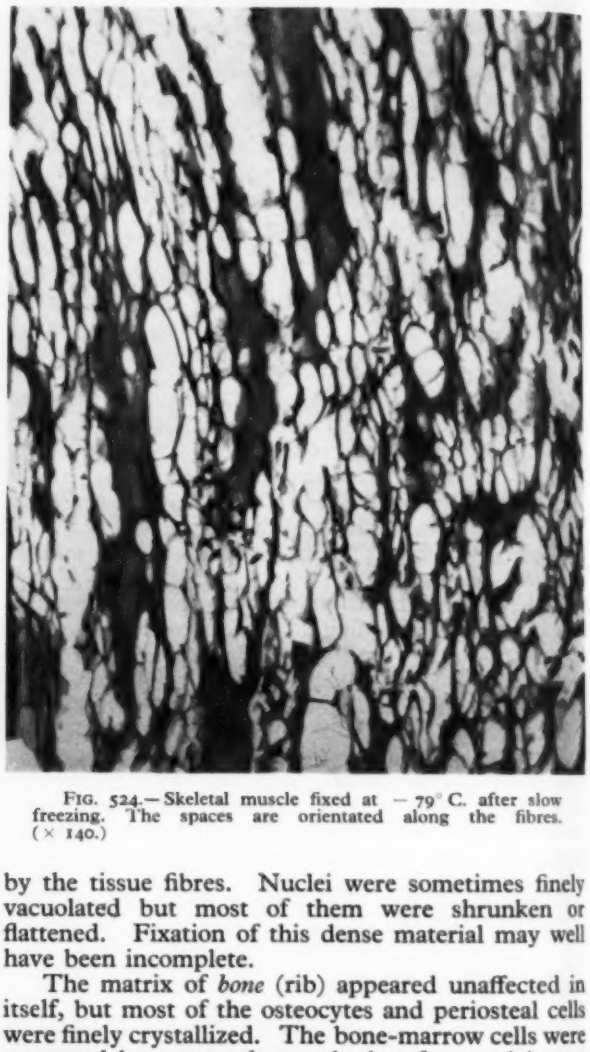

FIG. 524.—Skeletal muscle fixed at — 79° C. after slow freezing. The spaces are orientated along the fibres. (× 140.)

The *sciatic nerve* showed crystallization of the fibrous perineurium and of the contained nervous tissue, but the nuclei among the nerve-fibres were shrunken and darkly stained, and were only occasionally crystallized.

The *skin* of the ear was similar to the epithelium of the œsophagus in that there was both nuclear and extranuclear crystallization in the superficial layers while the basal nuclei appeared normal. The underlying dermis was crystallized but the cartilage appeared unaffected.

Skeletal muscle in transverse section showed a thin zone of fine vacuolation apparently just beneath the sarcolemma of each fibre, and inside this a zone of large circular or roughly oval ice-crystal spaces up to 23μ maximum diameter. In the middle of the fibre lay the bulk of the shrunken sarcoplasm sending out extensions between the ice-crystal spaces. In longitudinal section (*Fig.* 524) the crystals were seen to lie in rows along the muscle-fibres, intermingling with the contractile substance in which striations were visible. Some of the nuclei were crystallized.

Tendon (tendo Achilles) showed ice-crystal spaces more marked in some parts than others and orientated by the tissue fibres. Nuclei were sometimes finely vacuolated but most of them were shrunken or flattened. Fixation of this dense material may well have been incomplete.

The matrix of *bone* (rib) appeared unaffected in itself, but most of the osteocytes and periosteal cells were finely crystallized. The bone-marrow cells were separated by scattered crystals, but few nuclei were distended by crystals, more had multiple vacuoles, and some had no nuclear change.

In brief, when normal tissues are slowly frozen to — 79° C., two types of crystals are formed:—

1. Nuclear crystals, often large, single or multiple, and frequently rod-shaped, stretching the nuclear contents around their boundaries.

2. Extranuclear crystals, often large, round or rod-shaped. It was not possible as a rule to be sure if they lay inside or outside the cell membranes. Some nuclei shrink and seem to avoid crystallization and this may apply in addition to their cytoplasm.

DISCUSSION

In recent years, progress in the study of the survival of living matter after exposure to very low temperatures has increased the need for methods of

studying the histological appearances during such exposure. Several authors have examined suspensions of tissue at low temperatures, more recently by the aid of phase-contrast microscopy (Chambers and Hale, 1932; Smith, Polge, and Smiles, 1951; Harmer, 1953; Smith and Smiles, 1953). The later work has been linked with survival studies of spermatozoa of various animals and amœbæ and red cells after cooling, and the effects of glycerol and other survival-promoting substances have been investigated. The chief limitation of the methods is that cells can be observed only in suspension and then often in artificial media. The appearances of frozen whole tissue can be appreciated only by rendering it unchangeable at low temperatures by fixation or freeze-drying, so that it may be examined by ordinary histological methods after thawing. The present article deals with some preliminary attempts to develop such an approach.

The choice of two methods is suggested here—fixation in cold alcohol (Simpson, 1941), or freeze-drying (Koonz and Ramsbottom, 1939). A cold alcohol method for fixing tissues at temperatures ranging from + 4° C. to − 79° C. is simple to use and can be applied to both solid and fluid material, provided the latter contains sufficient protein to bind it together in the fixed thawed state, and that it is stirred carefully to avoid disintegration. The quality of fixation is improved by stirring and two weeks in cold alcohol is necessary for some tissues such as ovary which are difficult to penetrate. Trials with Lison's 'gendre fluid' (Pearse, 1953) and with 10 per cent formal alcohol have shown no improvement on cold absolute alcohol alone.

The alternative method of freeze-drying is also useful for this work, and it is surprising that such a widely appreciated method has not been used very much before to study the effect of different rates of freezing upon tissue structure. It seems ideal to be able to remove the ice crystals in vapour form and block or fix the remaining material in its frozen pattern. The appearances obtained by freeze-drying have closely resembled those by the cold alcohol method, but I have used the latter more because the range is greater and the appearances are those at − 79° C. (or other chosen temperature above this), while the frozen-dried material is dried at − 35° C. to − 45° C. However, the importance of freeze-drying in this connexion cannot be ignored, and one object of the present paper is to point out that crystallization effects in frozen-dried material have been regarded far too long as an obstacle to the achievement of 'good' preparations in freeze-drying work. Most of the work has involved faster quenching to reduce crystal size below the limits of resolution of the light microscope (*see* review by Bell, 1952). Although, of course, such efforts are necessary for other studies, there is an urgent need to examine the histological effects of slow freezing on whole tissues for some survive better after this than after rapid freezing. With most tumours, for example, slow freezing combined with rapid thawing has given better survival than rapid freezing, and slow thawing is deleterious (Craigie, 1954). The advantages of slow freezing in the survival of spermatozoa and ovarian tissue (Smith and Parkes, 1951) have been established. Thus 'artefacts' in frozen dried preparations can be turned to some purpose in the study of the effects of extreme cooling, and slow cooling in particular, on the histological appearances of tissues (including tumours). It is hoped that this article will establish a link between workers in the two fields of freeze-drying and survival after freezing.

The shape of the ice-crystal spaces in the liver deserves further comment, for rounded ends to the rod-shaped ice-crystal spaces were not expected. The rounding was not always even, often there was partial flattening and it cannot be denied that the surrounding tissue may have changed in shape when the crystals melted or that the surfaces of the ice-crystals were dissolved in the cold alcohol before fixation was complete. But both frozen-dried and cold alcohol-fixed material showed rounded crystal spaces and, furthermore, in the photographs of frozen suspensions published by Smith, Polge, and Smiles (1951), and the frozen-dried muscle of Koonz and Ramsbottom (1939), rounded crystals are distinctly identified. The author is thus of the opinion that the rounding of ice-crystal spaces illustrated in the present article shows the true state of affairs at − 79° C. after slow freezing. At this point it is worth noting that although some authors have produced illustrations of frozen-dried material in a 'dessicated' state looking shrivelled and shrunken, these appearances are determined by crystal formation and in turn by the rate of cooling and are not caused by drying. Material quenched rapidly to − 160° C. and frozen-dried shows very little distortion; the crystals (*see Fig.* 526) are extremely small and the removal of water leaves the solid material of the cells almost in its original plan. An intermediate picture is seen after quenching in CO_2 at − 79° C.

The success of cold alcohol fixation rests on the low solubility of ice in cold alcohol. The alcohol penetrates between the crystals and denatures the concentrated protein. Further alcohol treatment is necessary after thawing to complete dehydration of the material (bubbles may arise from the tissue for over 30 minutes while it is thawing in alcohol). At room temperature the tissues can be seen to change quite quickly from red to brown, so some further action of the alcohol may occur on the other tissue components when freezing is discontinued. The outlines of the crystals were clearer in soft cellular tissue such as liver and spleen than in fibrous tissue where they were sometimes incompletely surrounded, and where fibrous strands were torn. Most of the ice-crystal spaces in the liver at − 79° C. probably represented single crystals, but the largest spaces here and in other organs may have been filled by a collection of smaller crystals.

Large intranuclear crystals were a surprise finding, and the distortion of nuclear chromatin was so great that studies at higher temperatures were necessary for their recognition. They were particularly prominent in the liver, but even here a certain number of nuclei were unaffected. In some other tissues the nuclei contained numerous vacuoles which were probably crystalline in origin. As has been noted above, incomplete fixation may give a false impression of non-crystalline nuclei and the proportion of crystallized nuclei to non-crystallized increased as

fixation procedures were improved. For this reason some caution must be exercised in estimating the importance of these two appearances in any tissue. Nevertheless, prolonged fixation with continuous stirring has not abolished all uncrystallized nuclei and it seems very likely that the nuclei of a collection of similar cells may react in two ways to slow freezing :—

1. Ice-crystal growth within the nucleus aided by the passage of water from the cytoplasm across the nuclear membrane ;

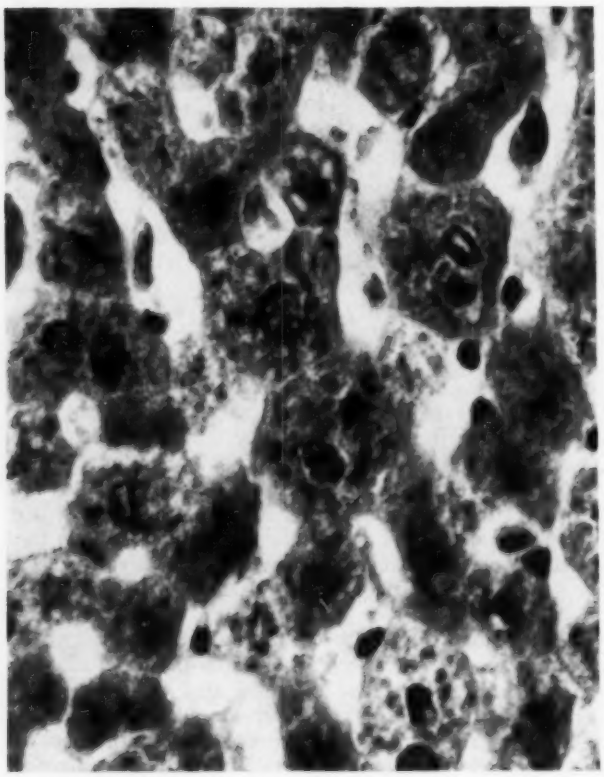

FIG. 525.—Liver slowly frozen and quickly thawed before fixation. Some nuclei show evidence of former crystallization. (× 700.)

2. Shrinkage of nucleus and no visible crystallization, nuclear water having contributed to extranuclear ice-crystals.

It is tempting to speculate on the significance of these findings and cell survival, but no conclusions have been reached yet. The form of nuclear adaptation to slow freezing may indicate the ability of the cell to survive the treatment, and shrinkage would seem more likely than crystallization to leave the cell viable.

The cytoplasm was concentrated and distorted by the crystals to such an extent that from the studies so far undertaken it has not been possible to decide whether extranuclear crystals were within the cytoplasm or outside the cell altogether. Cells with shrunken nuclei often seemed to have shrunken uncrystallized cytoplasm and nuclear and cytoplasmic shrinkage could prevent cell crystallization.

In conclusion it should be mentioned that when tissue is rapidly thawed after slow freezing it returns almost to normal, but careful examination of the nuclei reveals traces of evidence of crystallization in some nuclei (*Fig.* 525) and further findings in this connexion will be published later. The correlation of this work with survival studies is in progress.

SUMMARY

The storage of tissues at very low temperatures for surgical and experimental purposes is becoming increasingly popular but, to date, very little work has dealt with the appearances of tissues while in the frozen state. Two methods are described here for making permanent preparations of frozen tissue—namely, cold alcohol fixation and freeze-drying. Large nuclear and extranuclear ice-crystal spaces have been found in most slowly-frozen tissues and, if thawing is allowed before fixation, only a trace of these changes remains. Further work along these lines should contribute to our understanding of the effects of these low temperatures on tissues primarily with reference to cell survival.

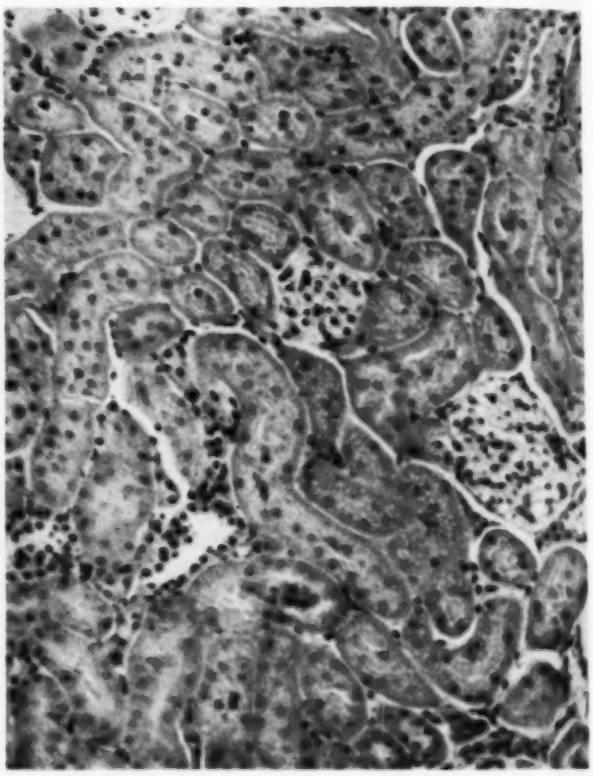

FIG. 526.—Kidney quenched rapidly in isopentane at — 160° C. and frozen dried. There are minute crystals in some tubules, but most of the tissue appears normal. (× 160.)

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SHORT NOTES OF RARE OR OBSCURE CASES

INFANTILE TERATOMA TESTIS

REPORT OF ONE CASE AND REVIEW OF THE LITERATURE

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TESTICULAR teratoma is an uncommon condition in the adult and a very rare condition in infancy. Infantile malignant disease has justly acquired a terrible reputation yet, strangely enough, the prognosis of teratoma testis, following simple orchidectomy, is excellent in the infant. Why is it that a disease, so fatal in the adult, is so benign in the young?

A possible explanation is that the teratoma, when large enough to diagnose in the infant, is in a quiescent phase; whereas the teratoma in the adult, also congenital, is then too small for detection. Some later change in the biological behaviour leads to a sudden increase in size, a belated diagnosis, and destruction of the host in a high proportion of cases.

The case reported here is typical of the few recorded in the past.

Overall Incidence of Testicular Tumours.—Dean (1935) estimated that tumours of the testis constituted 2·099 per cent of all malignant tumours in males. Other writers, notably Metassarin (1944), quote figures as low as 0·5 per cent. Ormond and Prince (1941) found only 21 cases of malignant testicular tumour in 319,000 out-patients seen at the Henry Ford Hospital between 1915 and 1951. Himwich (1922) reported an incidence of 1 in 1500 male surgical admissions to the Mayo Clinic, where only 102 cases had been seen up to 1928.

The relative frequency of seminoma and teratoma varies in the different series. Grevillius (1937) found that 59·2 per cent were seminomata; Gordon-Taylor and Wyndham (1947) 67 per cent; Hickinbotham (1950) 50·5 per cent. All agree, however, that considering all ages seminomata are slightly more common than teratomata.

Age Incidence of Teratoma Testis.—The age incidence varies with the author. Himwich (1922) found it to be greatest between 23 and 29 years. Dean (1935), in a review of 292 cases, found their ages to vary between 1 and 70 years. Gordon-Taylor and Wyndham (1947), in an analysis of 227 cases of teratoma testis, found the average age to be 29 years; the youngest being an infant of 5 months with a teratoma in an incompletely descended testis. Barringer and Earl (1941), in a review of 600 cases, found the youngest to be 9 months and the oldest 47 years, with an average of 31·5 years. Hickinbotham (1950) found an infant of 13 months in 39 cases of teratoma testis collected from the records of the Birmingham United Hospitals between 1936 and 1946.

Testicular tumours have been recorded at birth by various authors. Wilms (1896), reviewing 17 cases, recorded the age in 11; 4 of these were noticed at birth, 4 shortly after birth, and 3 in the early years of life. Cairns in his 1926 Hunterian Lecture traced 47 cases of testicular dermoid, of which 62 per cent were observed at, or shortly after, birth and 84 per cent within the first year of life.

Gordon-Taylor and Till (1938), reviewing 50 cases of malignant testis seen at the Middlesex Hospital up to 1938, found 1 infant aged 17 months with a teratoma testis.

Gross (1953) collected a series of 12 cases occurring in infants and young children: 3 of these were 1 year old or less; 4 were between 1 and 2 years; 4 were between 3 and 4 years, and 1 was 9 years old. Only 1 (an infant of 1 year) was a teratoma; 10 were carcinomata, and one was a Leydig-cell tumour. More recently, Rusche (1952), in a separate series of 12 juvenile cases, found 4 to be present at birth; 2 of which were adult teratomata; 1 a dermoid cyst, and 1 an embryonal carcinoma. Six of the remaining 8 were adult teratomata, and 2 were embryonal carcinomata. Ages at the time of diagnosis varied between 1 month and 12 years. Isolated cases have been reported by Twinem (1942) in a 3-year-old boy, Boehme, Bagley, and Pumphrey (1951) in an infant aged 4 months, and Wakeley (1938) in a boy aged 3½ years.

CASE REPORT

I. P. C., a well-developed male infant of 11 months, was admitted to the Children's Medical Ward with the history of a scrotal lump noticed soon after birth, and thought to be gradually increasing in size. He had not suffered from any previous illness apart from one attack of gastro-enteritis.

Clinical examination revealed a fit-looking baby with a tense circumscribed swelling, which transilluminated, in the left side of the scrotum. The testis could not be felt on that side. Continuous gentle pressure did not produce any reduction in the size of the swelling. The right testicle felt normal, and there was a small soft gland

FIG. 527.—Showing the cysts within the firm white tissue of the teratoma. (× ¾.)

in the right inguinal region. Nothing abnormal was palpable in the abdomen.

A surgical opinion was sought and exploration advised on the grounds that the swelling did not look or feel quite like a a hydrocele, and might well be a tumour undergoing cystic degeneration.

AT OPERATION (Oct. 1, 1953).—A transverse scrotal incision was made. The body of the testicle was found to be much enlarged, felt cystic, and contained several hard areas. There was no hydrocele and both epididymis and cord were macroscopically normal. Simple orchidectomy was therefore performed; the cord being pulled down and divided at the external ring.

PATHOLOGICAL REPORT.—"The bulk of the testis appears to be replaced by an encapsulated nodule measuring approximately 2 cm. in diameter. This nodule is composed of semitranslucent firm white tissue which contains a number of connecting cysts. These range in diameter from 1 mm. to 3 mm. The cysts, which are lined by smooth, greyish-white material, contain a slightly mucoid colourless fluid." (*Fig.* 527.)

HISTOLOGY.—Adult teratoma. (*Fig.* 528.)

MALE TOAD TEST (Oct. 10): Negative.

RADIOGRAPHY OF CHEST (Oct. 8).—Nothing abnormal detected.

PROGRESS.—Recovery was uneventful and the infant was discharged on Oct. 11. When seen six months later he was found to be fit with no evidence of any recurrence.

COMMENT

This tumour was almost certainly congenital, and it is possible that it arose from a totipotential sex cell capable of producing tissue representing any derivative of the three primitive germinal layers. Verneuil in 1855 considered that all testicular dermoids were congenital—a conclusion in which Cairns concurred in his 1926 review.

Diagnosis should be easy in the infantile cases if the possibility of a tumour is considered. Choice is limited to a hydrocele, hæmatocele, hydrocele in a hernial sac, gumma, or tumour. The history of a swelling present at or soon after birth, the feel, the failure to transilluminate—all indicate a solid 'tumour' and point to early exploration. This case was complicated by the fact that the teratoma was cystic in parts, and therefore transilluminated. It was, however, too tense, too circumscribed, and did not feel right for a hydrocele. It is of interest that the case reported by Wakeley was initially diagnosed as a hydrocele for the same reason.

Hormonal tests are unreliable and are only likely to be positive in undifferentiated tumours, particularly those with metastases. Lowsley (1942) came to the conclusion that less than 25 per cent showed a positive reaction. Metassarin (1944), on the other hand, found that gonadotrophic hormone was present in diagnostic amounts in 85 per cent of his cases.

Prognosis.—The prognosis following simple orchidectomy is excellent with both dermoid cyst and adult teratoma. Cairns considered the dermoid cyst to be benign and could find no authentic case of spread by metastases up to 1926. I have only been able to find 1 fatal case of adult teratoma in a child, and that was reported by Gordon-Taylor (1947) in

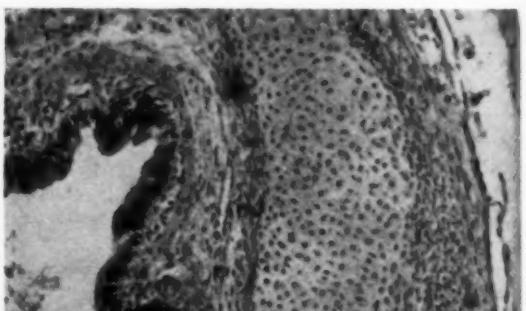

FIG. 528.– Photomicrograph showing the structure of the tumour. (× 105.)

an infant of 5 months with a teratoma in an undescended testicle who rapidly died with widespread metastases. Rusche's (1952) 8 cases were all alive and well—one 24 years; one 13 years; four 8 years; one 4 years, and one 2 years after operation. Gross's single case (1953) treated by orchidectomy and 800 r prophylactically to the scrotum, was alive

and well 4 years after operation. The infant of 17 months reported by Gordon-Taylor (1938) was well, with no evidence of recurrence 11½ years after operation. Dean's (1935) case, a boy of 3 years, whose testicular swelling was noted at 1 year and who was treated by simple orchidectomy, was alive and well 2 years later.

How different is the prognosis of teratoma testis in the adult. The Mayo Clinic reported a 'five-year cure rate' of 26·4 per cent in 1941. Their cases were treated by orchidectomy and post-operative irradiation. Gordon-Taylor (1947), reviewing 636 cases in his Skinner Lecture, reported only 18 per cent alive and well after 5 years.

Treatment.—The treatment of choice would appear to be simple orchidectomy, done through an inguinal incision, with preliminary ligation of the separated vas deferens and vessels at the internal ring. Gross (1953) advocates opening the peritoneum and palpating along the iliac vessels. If nodes are found in this area, he considers that the incision should be enlarged so that the abdomen can be entered extensively, and tumour tissue along the great vessels or brim of the pelvis removed.

I have no experience of the Hinman-Chevassu operation, but Rusche's (1952) figures suggest that it is unnecessary in the infant with teratoma testis, and that it has been replaced by deep irradiation in embryonal carcinoma. The potential damage to the opposite testis, and adjacent centres of ossification, should make one wary of prophylactic irradiation in these cases.

It would seem reasonable to reserve post-operative irradiation for embryonal carcinomata, particularly those with suspected metastases.

SUMMARY

A case of adult teratoma testis occurring in an infant of 11 months, treated by simple orchidectomy, is reported.

The literature is reviewed and attention is drawn to the excellent prognosis in these cases. A plea is made for early diagnosis.

I wish to record my thanks to Dr. Forest Smith, under whom the case was admitted; and to Mr. T. W. Mimpriss, who performed the operation.

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LIPOMA OF THE ŒSOPHAGUS

REPORT OF A CASE

By J. S. KINNEAR, DUNDEE

BENIGN tumours of the œsophagus are of interest because of their relatively infrequent occurrence, and the present case is reported both on that account and also since no other instance of a lipoma combining the same features of size, structure, and anatomical situation could be found in the available literature. Those which are reported usually possess a long narrow pedicle and are situated in the introitus or upper third of the œsophagus; they frequently make their presence known by causing an irritation in the gullet which results in vomiting, and the tumour is ejected at the mouth, still attached to its long narrow pedicle. The present case is one of a bulky, submucous, non-pedunculated lipoma, situated in the lower half of the œsophagus.

In a recent article in the BRITISH JOURNAL OF SURGERY, Flavell (1953) gives a comprehensive review of the present attitude towards simple œsophageal tumours, and points out the necessity for reconsideration of their apparent rarity, with the recent advent of modern methods of investigation, diagnosis, and treatment. In 1945, however, Adams and Hoover analysed all simple tumours of the œsophagus which had been reported in the preceding two hundred and twenty years and found that only 5 of these were due to lipoma, while of 7 cases reported by Harrington and Moersch in 1944, 3 were lipomata, but of the pedunculated variety. Vinson reported 1 such case in 1922, as also did Garretson and Hardie in 1928.

CASE REPORT

A man, D. D., aged 44 years, was first seen on his doctor's recommendation at the Surgical Out-patient Department of Dundee Royal Infirmary, on June 5, 1953. His presenting symptoms were retrosternal pain, heartburn, acid regurgitation, and flatulence, of about two years' duration. He noticed that his tongue had been furred for about six months and, for the five or six weeks prior to his first attendance, he had been bringing up white frothy material, although there had been no actual vomiting of food. He had no difficulty in swallowing, but was aware of the swallowed material being arrested about the level of the xiphisternum. This gave

rise to pains across his chest from left to right at the level of the lower end of the sternum. In the previous eighteen months, he had lost about 1 st. in weight, but during that time had been modifying his diet in the hope of relieving his symptoms. There was no history of hæmatemesis or melæna.

FIG. 529.—Radiographic appearance of lower end of the œsophagus after a barium swallow, showing relationship to heart shadow.

FIG. 530.—Radiographic appearance of œsophago-gastric anastomosis, one month after operation.

ON EXAMINATION.—He was a tall, adult man, of spare build, but no abnormal clinical signs could be elicited, either in the chest or the abdomen. The result of X-ray examination of the œsophagus, following a barium meal, is depicted in *Fig.* 529. The filling defect was at first thought to be in the nature of a bezoar, but closer examination revealed its attachment to the posterior wall of the œsophagus, towards the left side. There were also well-marked peristaltic contractions of the lower portion of

FIG. 531.—Operation specimen, with rubber tube in the lumen of the œsophagus, and portion of tumour protruding from the upper end.

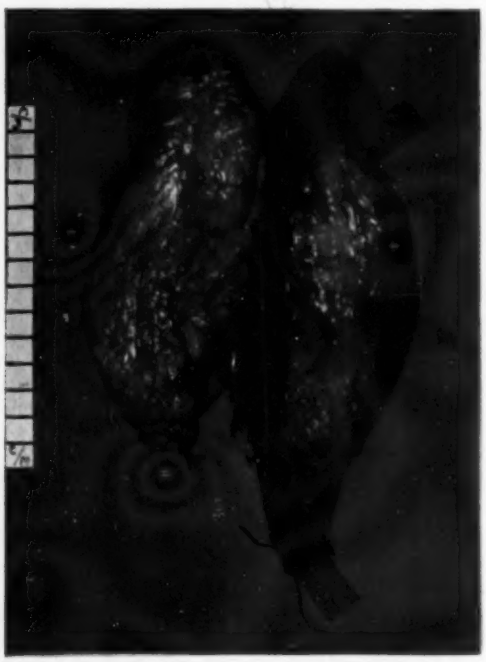

FIG. 532.—Operation specimen, split longitudinally, showing rubber tube in the lumen of the œsophagus, and the broad base of the tumour.

the œsophagus and a spasmodic hold-up of the barium at the cardiac sphincter. There was no evidence of a pulmonary or mediastinal lesion on radiographic examination of the chest. Œsophagoscopy revealed a large smooth tumour, covered by normal-looking mucosa, which protruded from the posterior wall into the distended lower half of the œsophagus. Mobility was unimpaired. He

FIG. 533.—Edge of the base of the lipoma, showing its submucous origin. (× 6.)

was admitted to the surgical department of Maryfield Hospital, Dundee, on July 9, 1953, with the provisional diagnosis of a large simple œsophageal tumour.

AT OPERATION (July 11).—Entry was gained through a left thoraco-abdominal incision, removing a portion of the seventh rib. The visceral and parietal layers of pleura were intimately fused from an old healed pleurisy over the whole extent of the left lower lobe and rendered dissection slow and difficult. When the œsophagus was displayed, a large soft intramural tumour was found to be present, extending from immediately below the arch of the aorta to the level of the diaphragm. The œsophagus itself was not unduly adherent to surrounding structures. Resection was decided upon and the abdominal part of the incision was completed. The œsophagus containing the tumour was resected from 1 in. below the arch of the aorta to its termination, and an œsophago-gastric anastomosis was performed.

PROGRESS.—Post operative progress was somewhat difficult and protracted by reason of collapse of the lower lobe of the left lung which necessitated bronchoscopic suction in its treatment, and the later development of thrombosis of calf veins.

On Aug. 27, X-ray examination after a barium swallow was carried out (*Fig.* 530).

Subsequent convalescence was uninterrupted, and when the patient was seen one month after his discharge from hospital he had no symptoms and his general condition was considered to be satisfactory.

PATHOLOGICAL REPORT.—The specimen consisted of a resected segment of œsophagus containing a tumour within the lumen. The whole specimen measured approximately 20 cm. in its long axis and 6·5 cm. at its widest part. It was roughly fusiform in shape and, at the upper end, a spherical tumour mass protruded, which measured 5 cm. in diameter (*Figs.* 531, 532).

The specimen was split longitudinally and the section revealed a large tumour, almost entirely occupying the œsophageal lumen, with the muscular wall considerably stretched over it. The lumen was still patent and it was possible to pass a rubber tube 1·5 cm. in diameter, between the growth and the anterior wall of the œsophagus. The tumour appeared to be of a fatty nature and arose from a broad base attached to the left posterolateral wall of the œsophagus. The tumour measured 16 cm. in length and 4·5 cm. across its widest part, while the base measured 12 cm. in length.

Histologically, the tumour proved to be a submucous lipoma. The mucosa was hypertrophied and thickened on the free surface and there was a moderate degree of hyperkeratosis, with underlying chronic inflammatory infiltration. Some areas of superficial ulceration were observed, both on the surface of the tumour and on the adjacent œsophageal mucosa (*Fig.* 533).

I wish to express my thanks to Mr. W. G. Campbell, in whose Surgical Unit this case was treated; to Mr. M. J. Gibson and Mr. A. G. Gibb for their professional assistance; and to the Departments of Pathology and of Surgery, The Medical School, Dundee, for the illustrations and examination of the specimen.

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A CASE OF LOCALIZED ARTERIOVENOUS FISTULÆ

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SINGLE or multiple arteriovenous fistulæ may occur as a result of an error in development of the vascular system or following a wound penetrating an artery and its neighbouring vein. In the latter case there is usually little doubt as to its origin, whilst the congenital case is usually characterized from an early age by multiple fistulæ leading to a series of changes

FIG. 534.— Photograph of the varicosity running from the left buttock.

in the affected parts. It must be unusual for arteriovenous fistulæ to become apparent in a young adult, without history of preceding trauma and involving a strictly localized portion of artery and vein.

CASE REPORT

HISTORY.—The patient, a young man aged 19 years, was first seen in March, 1953, complaining of a swelling in the left buttock. He had first become aware of this three years previously, and it had gradually enlarged over this time. Since its appearance the patient had experienced attacks of cramp-like pain down the left thigh and calf, only relieved by lying down. Three months previously he had had a varicose vein ligated in the upper posterior left thigh without relief of his symptoms. In 1949 he had had an operation for an undescended left testicle.

ON EXAMINATION.—He was a fit-looking young man with an obvious goitre, but no evidence of thyrotoxicosis. Inspection of the limbs revealed a very large varicosity running from the prominence of the left buttock down the back of the left thigh to the scar of the ligation performed three months previously (*Fig.* 534). This vein was tense even when the patient was lying prone, but could be compressed by moderate pressure. Pulsation was clearly discernible over a wide area centred around the varicosity on the buttock, and palpation here revealed a more deeply placed swelling about 2 in. across, with ill-defined edges and situated over the greater sciatic notch but under the gluteus maximus muscle. Its most striking physical characteristic was expansile pulsation ; it collapsed under firm pressure, refilling promptly on release ; a vascular thrill, and, on auscultation, a systolic bruit were easily detected. Compression of the swelling gave rise to a perceptible slowing of the pulse from its resting rate of 88, to 76 per minute, and caused a definite elevation of the diastolic blood-pressure from 125/70 to 125/95. Both limbs were of identical length and appearance. The heart showed no enlargement on radiography and hæmoglobin was 108 per cent or 16 g. per 100 ml.

A provisional diagnosis of an arteriovenous fistula of the left internal pudendal vessels was made. There was no history of injury to this area.

AT OPERATION.—As a first step the left common iliac artery was exposed extraperitoneally through a left oblique abdominal incision and encircled with a tape so that its temporary occlusion might be rapidly brought about if necessary. The patient was then repositioned and a ' question-mark ' incision made around the gluteus maximus in the fashion recommended by Henry (1945). The insertion of the gluteus maximus was now divided to reflect it medially, exposing the sciatic region. Emerging through the greater sciatic notch and from under the pyriformis muscle was an enormously distended vein running over the sacrospinous ligament back into the pelvis through the lesser sciatic notch, giving off several branches to the gluteus maximus and presumably in direct communication with the superficial varicosity (*Fig.* 535). The vein, clearly the internal pudendal, was pulsating vigorously, and through its thin stretched wall the turbulence of the blood within was easily seen. A test occlusion of the common iliac artery caused the pulsation and turbulence in the vein to cease immediately. The internal pudendal artery was completely overlapped by the vein. Further dissection showed two points of communication between the artery and the vein, one direct and the other by a tortuous vessel (*Fig.* 536). The internal pudendal artery and vein were carefully isolated and divided between ligatures at their most proximal and distal accessible points to remove about 1¾ in. of the vessels, together with a long branch running to the gluteus maximus. All other vessels in the region were normal. The gluteus maximus was now replaced and the skin sutured. The superficial varicosity was found even at this early stage to be thrombosed. The tape was then removed from around the internal iliac artery and the abdominal wound closed.

PROGRESS.—The patient made an uncomplicated recovery, rapidly regaining normal function with complete relief of his symptoms. Review six months after the operation confirmed the complete return to normal, the varicose vein being only evident as a hard cord, the lower limbs being normal in all other respects.

DISCUSSION

The appearance of a large varicosity well away from one of the usual sites should always arouse suspicion of an unusual origin, and this case comes as a timely reminder of one possible cause.

There is little to indicate the true aetiology of the fistulæ. It is interesting that the condition should first manifest itself soon after a left orchidopexy. The patient, however, has no memory of any injection in the buttock at that time, but it is just conceivable that such an injection, long since forgotten, might have transfixed both artery and vein. We doubt, however, if this was the cause ; nor is

there any reason to suppose that they might have arisen as a result of a mycotic aneurysm rupturing through into the vein, as has been described in at least one case (Yater and others, 1940).

and many other changes being consequent upon the shunts between arterial and venous systems (Holman, 1937; Seeger, 1938; Allen, Barker, and Hines, 1947).

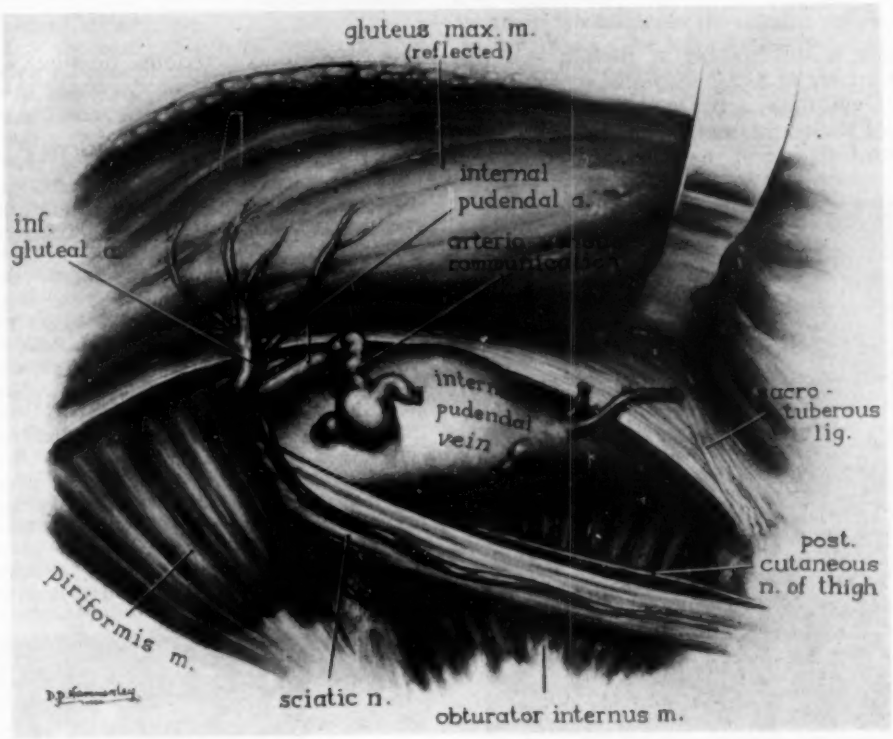

FIG. 535.—The findings at operation after the gluteus maximus muscle had been reflected.

The remaining explanation is that of a developmental error. Such congenital fistulæ are usually multiple, affecting extensively the arterial channels

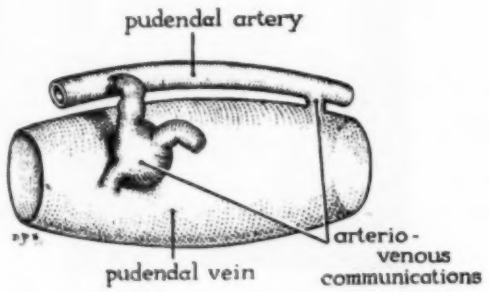

FIG. 536.—Diagram to show the arrangement of the arteriovenous communications.

of the head and neck or a limb, giving rise to a series of changes so that the skin is discoloured, the veins prominent, gigantism of the affected limb may be present, there is arterialization of the venous blood, and often the pulse-rate is rapid, but slowing when the main artery is compressed (Branham, 1890), these

In spite of the late appearance and restricted portion of artery and vein involved, an error in development seems to be the most likely explanation for the case described.

We wish to thank Mr. D. P. Hammersley, Medical Artist in the Department of Surgery, for the illustrations; and the Department of Photography, University of Durham, for the photographs.

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* These comprehensive surveys contain very full references to all the original contributions on congenital arteriovenous fistulæ.

HYDATID CYST PRODUCING OBSTRUCTIVE JAUNDICE

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HYDATID disease is uncommon in Britain and the occasional appearance of a case may lead to confusion in diagnosis. Dew (1948, a, b) states that intrabiliary rupture is one of the commoner of the major complications of hydatid disease of the liver. The rupture

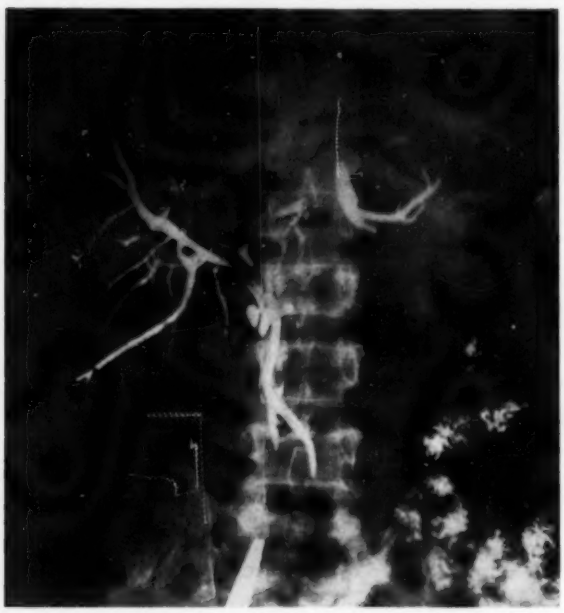

FIG. 537.—Cholangiogram made after first operation. The cyst was ultimately found in the area immediately above the dilated left hepatic duct.

takes place most frequently into one of the larger intrahepatic ducts and is likely to occur even with a small centrally placed cyst. The debris frequently passes into the duodenum and pieces of laminated membrane may be discovered in the washed fæces. Obstructive jaundice and cholangitis are common. Dew also finds that the commonest age for rupture is between 35 and 45, that occasionally some injury precipitates the rupture, and that the ensuing biliary colic is less severe than that caused by gall-stones. Diagnosis is suggested by considering the lower age group, the absence of previous attacks, the liver enlargement, and the intermittent non-progressive nature of the jaundice. It is confirmed by finding hydatid debris in the fæces, by radiology, and by positive hydatid tests. Frequently infection of the cyst occurs after rupture, and Dew recommends that treatment should be adequate drainage of the ensuing hepatic abscess.

Most authorities, e.g., Dévé (1918, 1925), Mills (1926, 1927), agree that infestation with hydatids occurs in infancy and that symptoms only begin to appear from twenty to forty years later. The likelihood of suppuration of cysts increases with age; and eosinophilia is an inconstant finding. Dévé describes gall-bladder enlargement as a common occurrence, and has found it to contain variously bile, pus, hydatid concretions, or simply mucus. Mills mentions a condition similar to the case described and calls it hydatid pseudolithiasis.

CASE REPORT

The case considered here is of a male maintenance engineer, aged 37, who was first admitted to hospital in December, 1950, suffering from colicky epigastric pain, vomiting, and jaundice of two weeks' duration. His temperature was 102.6°. The only previous illnesses of note were a severe attack of gastro-enteritis which had kept him off work for several months two years before, and a leg injury in boyhood. He was born in Swansea and had lived there until the age of 18, when he had come to work in London, where he had remained ever since. He had never been abroad. As a child, his home was very close to a slaughterhouse and he had frequently played with the sheepdogs there.

ON ADMISSION.—He complained of severe epigastric pain which radiated through to his back and down to the umbilical region, and which was associated with heartburn and flatulence. As the jaundice deepened, the pain became more severe. His stools were light in colour and his urine dark. He had lost about 1 st.

FIG. 538.—Sagittal section through the portion of liver removed at second operation. The intrahepatic position of the cyst is well shown.

in weight. His liver was regularly enlarged and rather tender. The gall-bladder was palpably distended, but there was little muscle guarding.

Among the investigations carried out were :—

Blood-count : Hæmoglobin 11·25 g. = 80 per cent. White blood-cells 10,990 per c.mm. (Polymorphs 86, Lymphocytes 9, Eosinophils 1, Monocytes 4).

Urine : Urinary diastase—200 units per c.c.

Blood : Serum-amylase 66 units per c.c.
Serum-bilirubin 6·4 mg. per cent.

Serum-thymol turbidity 2 units.
Serum-alkaline-phosphatase 21·0 units per cent.
Serum-proteins total 7·1 per cent.
Albumin/globulin ratio 2·4/1.

W.R., Kahn, Paul-Bunnell tests, and tests for leptospiral agglutinins were all negative.

After a few days the patient's general condition improved, the temperature became normal, and the jaundice lighter; but a week later all his symptoms recurred again, with a high pyrexia. A diagnosis of obstructive jaundice with cholangitis was made.

AT OPERATION.—An exploratory operation was undertaken ten days after admission. At laparotomy the liver was seen to be smoothly enlarged and congested, with no obvious cystic areas; the gall-bladder was greatly enlarged, but had apparently recently partially emptied and become flaccid. The common bile-duct was dilated but not tense. When it was opened several whitish grape-like structures presented and were readily removed. No other obstruction was found, and a probe passed easily downwards into the duodenum. The structures removed were recognized as hydatid daughter cysts and the main cyst was presumed to be deep in the liver. Accordingly the common duct was sutured around a Kehr's tube and the abdomen closed.

The largest cyst removed was 2½ cm. in its widest diameter and contained many degenerate scolices and hooklets. The patient re-acted strongly to a Casoni intradermal test, and the Ghedini-Weinberg complement-fixation test for hydatid was also strongly positive. The eosinophil count rose as high as 7 per cent in the first post-operative week. Radio-opaque fluid was injected through the common duct drainage-tube: a cholangiogram was made and is shown in *Fig.* 537. It was seen that there was adequate drainage into the duodenum and the tube was removed on the tenth post-operative day.

Three weeks after the operation, when the jaundice had almost gone, he had a third febrile attack with a recurrence of pain. The jaundice recurred, but again he recovered after three days of penicillin and streptomycin. All the liver function tests became normal except for a slightly raised serum-bilirubin and alkaline phosphatase and he was discharged eight weeks after his first admission.

ON RE-ADMISSION.—One month later he was re-admitted suffering from the same severe colicky abdominal pain. He was sallow but not clinically jaundiced. His temperature, normal at first, rapidly rose to 103° and jaundice recurred: a diagnosis of cholangitis was again made. It was here noted that although he had become jaundiced, with raised serum-bilirubin and alkaline phosphatase, his stools were completely normal in colour.

SECOND OPERATION.—A second laparotomy was done two weeks later, after the attack had subsided. The liver was seen to be normal in size and this time a lighter rounded area presented on the diaphragmatic surface of the left lobe. The rounded area seemed to be cystic and, on reviewing the original cholangiogram, it became obvious that this was in the silent area between the main branches of the left hepatic duct. As the rest of the liver was smooth and regular, the left lobe was mobilized as far as the left border of the inferior vena cava and resected flush with it. The left hepatic duct was ligated and the cut surface of the liver sealed off by a series of mattress sutures reinforced by omentum. The abdomen was closed with drainage. The removed portion of liver contained a complete hydatid cyst 5 cm. in diameter. (*Fig.* 538.)

There was a little bile-stained serous discharge from the wound for several days, but otherwise recovery was uneventful and all liver function tests became normal. The patient rapidly regained his normal weight and had no further pain. One year later his Ghedini-Weinberg complement-fixation test had become negative, suggesting that there were no undiscovered hydatids left behind.

DISCUSSION

The case described is of a patient whose pain suggested a mild biliary colic, but whose gall-bladder was palpably enlarged and not markedly tender. A second point of confusion was the apparent obstructive jaundice with a normally coloured stool. This is presumed to have occurred when only the left hepatic duct was obstructed. It is likely that the cholangitis and infection were confined to the left side of the liver as it was noted in the resected specimen, and all symptoms quickly subsided after the left lobe was resected.

SUMMARY

Recurrent jaundice and cholangitis was caused by the presence in the left lobe of the liver of a hydatid cyst which had ruptured into the left hepatic duct. Complete relief was obtained by resection of the area of liver which contained the offending cyst. The positive Ghedini-Weinberg test became negative one year after the resection.

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REVIEWS AND NOTICES OF BOOKS

The Surgical Appendix. By M. V. BHAJEKAR, M.A. (Oxon.), M.B., B.Ch. (Oxon.), F.R.C.S. (Edin.), Bombay. With a Foreword by DAVID H. PATEY, M.S., F.R.C.S., Surgeon, Middlesex Hospital, London. 7¼ × 4⅞ in. Pp. 134 + xiv, with 9 plates. 1953. Bombay: Indian Journal of Medical Sciences. Rs. 5.

THIS is a small book which students will value for it contains in a small compass a wealth of material concerning the various surgical conditions of the appendix. Mr. Bhajekar has added some brief biographical sketches of those who have contributed to our knowledge concerning appendicitis and its treatment. The names of Treves, Murphy, Ochsner, Sherren, Moynihan, McBurney, Fowler, and Battle have been given pride of place in this small monograph. It is a pity the author did not obtain better pictures of these famous surgeons.

La Petite Chirurgie des Fistules Anales. By JEAN ARNOUS and ERNEST PARNAUD. 9¾ × 6¾ in. Pp. 134, with 17 illustrations and 5 colour plates. 1954. Paris: Masson et Cie. 1000 fr.

THE main purpose of this monograph is to stress the advantages of ambulatory methods for the treatment of fistula-in-ano. The subject of course is not a new one, and a good bibliography is given of previous suggestions for the use of setons and rubber bands, etc., both before and after the time of William Allingham. The anatomical description of the anal sphincters and related spaces follows that given by Courtenay. A classification of fistulæ into four groups is described, which closely follows that of Milligan and Morgan; it is agreed that the great majority of fistulæ arise in the anal canal, and that only exceptionally does a fistula originate from extrarectal structures. The role of the intramuscular glands is described and well illustrated, and a long consideration is given of the incidence of tuberculous fistulæ as estimated by different authors.

The ambulatory method for laying open fistulæ has been carried out by the authors in 478 cases and the results are tabulated in respect of 382 traced cases. The method advocated appears to be most suitable for the direct low-level type of fistula and is clearly illustrated; it involves a preliminary period of six weeks' drainage by an indwelling loop of nylon, and then the fistula is laid open under local anæsthesia with cutting diathermy; the portion of sphincter to be divided is sectioned bit by bit by a rubber ligature which is replaced at weekly intervals. The entire process appears to be a very lengthy one, extending over twelve weeks or sometimes longer.

Although this type of operation has not been popular in this country for many years, it may perhaps deserve consideration in carefully selected cases for economic reasons, including the severe pressure on hospital beds at the present time. This monograph is well produced and the authors' final conclusions are put very fairly. The preface is written by Dr. Jacques Caroli, and the historical introduction will prove of interest to all who have to deal with this problem.

Surgical Technigrams. By F. M. AL AKL, M.D., Associate Attending Surgeon, Kings County Hospital, N.Y. 9¾ × 7¼ in. Pp. 346 + xiv, with a large number of illustrations in line. 1954. New York and London: McGraw-Hill Book Co., Inc. 96s.

THE title of this book may seem peculiar to surgeons in this country when it simply means surgical operations. The so-called 'technigrams' are line drawings depicting various stages of all the common or everyday operations in a hospital.

The line drawings are simple and instructive and are not spoilt by too much detail. With the drawings there are notes explaining the anatomy of the region concerned in any operation, together with an account of the operative technique. There are some thirty-six operations included in this volume and the student and post-graduate will find that it is upon these operations that he is likely to be questioned in his final examinations.

A useful practical reference volume.

Neck Dissections. By JAMES BARRETT BROWN, M.D., and FRANK MCDOWELL, M.D., Washington University School of Medicine, St. Louis, Missouri. 8½ × 6 in. Pp. 163 + viii, with 82 illustrations. 1954. Springfield, Ill.: Charles C. Thomas. (Oxford: Blackwell.) 54s.

THIS is a useful and stimulating book for the practical surgeon who is faced with the treatment of malignant glands in the neck, for it presents a new outlook. It is well known that rapid therapeutic treatment will not in itself cure malignant glands in the neck. Therefore a more extended surgical excision is necessary if patients are to survive five years.

The authors of this excellent monograph have illustrated it with many clinical photographs depicting the pre- and post-operative conditions. Perhaps the best part of the book is that devoted to the actual surgical technique of a block dissection of the cervical glands, including the removal of the sternomastoid muscle and the internal jugular vein. There are a series of coloured drawings showing the various stages of the block dissection of the glands in the neck; these are really beautiful.

To-day removal of part or the whole of the lower jaw can be carried out without detriment to the patient, for the plastic surgeon can easily replace the jaw by a bone-graft. The younger generations of surgeons will be grateful to the authors of this book because it will have given them courage to emulate their example and obtain better results in the treatment of an all too common condition.

Heart. A Physiologic and Clinical Study of Cardiovascular Diseases. By ALDO A. LUISANDA, M.D., Associate Professor of Medicine and Director Division of Cardiology at the Chicago Medical School; etc. With a Foreward by HERRMAN L. BLUMGART, Physician-in-Chief, Beth Israel Hospital; Professor of Medicine, Harvard Medical School. Second edition. 10 × 6¾ in. Pp. 680 + xiv, with 312 illustrations. 1954. (Baltimore: The Williams & Wilkins Co.) London: Baillière Tindall, & Cox. 114s.

THE new second edition of this comprehensive work shows signs of careful revision and some one hundred illustrations have been introduced. The progress and changes in cardiology have been very marked in the last six years and this book incorporates them all.

The author with his background of extensive research and clinical pharmacology has presented a very valuable and readable account of the various drugs which are of use in the treatment of cardiac diseases. One of the highlights of this volume is the excellent survey of European as well as American thought and practice.

An excellent production and a reliable and most useful reference volume.

Amputations. By LEON GILLIS, M.B.E., M.B., B.Ch., M.Ch., Orth., D.L.O., F.R.C.S., Consultant Orthopædic Surgeon to Queen Mary's (Roehampton) Hospital, London; etc. 9¾ × 7¾ in. Pp. 423 + xii, with 342 illustrations. 1954. London: William Heinemann Medical Books Ltd. 84s.

THE time is ripe for the publication of such a book as this, for the experience gained by two World Wars and the Korean conflict have produced a wealth of clinical observation which should see the light of day. We are living in a mechanical age which itself is responsible for many traumatic injuries on the roads both at home and abroad.

This comprehensive work deals with the surgery of amputations and the author has made use of his matured experience at Queen Mary's Hospital, Roehampton, a centre which has earned a world-wide reputation.

We are glad to see that the author does not condemn Syme's amputation as so many modern orthopædic surgeons are prone to do. In the lower extremity a Syme amputation only carries a 30 per cent disability while one at the ideal site, 5 in. below the knee-joint, produces a 50 per cent disability. This fact deserves to be more widely known.

Leon Gillis has devoted considerable space to civilian conditions which produce ischæmia as a result of vascular diseases, and the subject of the management of congenital deformities receives well-merited special attention.

The illustrations, which are numerous, are of a high order and do enhance the value and usefulness of the book.

There can be no doubt that this work will be the reference volume for many years and will be used by students and postgraduates, for it is the first comprehensive contribution which has been published in the British Isles.

The Bilroth I Gastric Resection. With Particular Reference to the Surgery of Peptic Ulcer. By HORACE G. MOORE, jun., M.D., formerly Instructor in Surgery, University of Washington School of Medicine; and HENRY N. HARKINS, M.D., Ph.D., F.A.C.S., Professor of Surgery and Executive Officer of the Department of Surgery, University of Washington School of Medicine. 10½ × 7¾ in. Pp. 175 + xx, with 49 illustrations. 1954. (Boston: Little, Brown & Co.) London: H. K. Lewis & Co. 56s. 6d.

THIS book gives an excellent account of the Bilroth I operation for gastric resection. The authors give an interesting survey of the historical development of gastric surgery up to the present time.

Although many English surgeons make use of the Bilroth I procedure for selected cases of peptic ulcer yet we do not think it will ever be universally used because of the difficulty in some cases of the mobilization of the duodenum and the tendency to stomal obstruction. This book sets out in detail the operative technique of the Bilroth I operation, and after reading this well-illustrated volume it certainly leaves one with the impression that this method of treating peptic ulceration is worthy of a more extended trial.

The book will remain the reference volume on this operation for many years to come.

Retropubic Prostatectomy for Benign Enlargement of the Prostate Gland. By FRANCIS A. BENEVENTI, M.D., F.A.C.S., New York. 11 × 8½ in. Pp. 227 + xiv, with 44 original drawings by WILLIAM P. DIDUSCH. 1954. Springfield, Ill.: Charles C. Thomas. (Oxford: Blackwell.) 50s.

MONOGRAPHS dealing with special conditions and operative technique are useful if they add something to our knowledge. The present one does not greatly increase our knowledge of this important organ. The anatomical dissections are not good and do not reveal any detail of the essential parts.

The operative technique is well described and differs little from Millin's, although it is called the author's technique. Perhaps the best chapter in this book is that devoted to osteitis pubis; this is well written and is instructive and an admirable bibliography is given at the end of the chapter.

It is interesting to note that spinal anæsthesia supplemented with gas-oxygen or pentothal was the type of anæsthesia usually employed by the author. The post-operative hospital period was between 14 and 24 days in hospital cases and between 10 and 14 days with private patients.

The history of prostatectomy given at the end of the book makes interesting reading.

Diagnostic Advances in Gastrointestinal Roentgenology. Selected Methods with Clinical Evaluation. By ARTHUR J. BENDICK, M.D., Director of Radiology, Beth Israel Hospital, New York. 10 × 6¾ in. Pp. 131 + xii, with 75 illustrations. 1954. New York and London: Grune & Stratton Inc. $6.

THE greatly improved X-ray apparatus has made possible better and better detail in X-ray films. Dr. Bendick in his monograph, which is well illustrated with radiographs, has placed considerable emphasis on detailed mucosal study in the differential diagnosis between benign and malignant tumours of the alimentary tract.

The book is basically a practical one which can be used for ready reference. It emphasizes recent developments in apparatus, in X-ray technique, and in diagnosis. It does not attempt to replace the complete reference book of X-ray examinations, but rather to supplement these works by bringing them up to date with selected advances.

It should appeal both to the radiologist and clinician, for it is the more detailed examination by X rays that can help both in coming to a diagnosis in a difficult case.

The importance to-day of cholangiograms in the treatment of gall-stones is stressed, and if this method were more widely used there would be fewer stones overlooked in the common bile-duct.

Demonstrations of Physical Signs in Clinical Surgery. By HAMILTON BAILEY, F.R.C.S., F.A.C.S., F.R.S.E., Emeritus Surgeon, Royal Northern Hospital, London; etc.; assisted by ALLAN CLAIN, M.B. (Cape Town)., F.R.C.S. Twelfth edition. 8½ × 5½ in. Pp. 456 + xii, with 681 illustrations, many in colour. 1954. Bristol: John Wright & Sons Ltd. 38s. 6d.

THE new twelfth edition of this well-known book on physical signs will be welcomed by students both at home and abroad. The illustrations and clinical photographs, many of which are in colour, could not be bettered.

This is one of the essential books for students, for it teaches them to use their clinical senses and not to rely entirely on ancillary aids to diagnosis. There is a great tendency to-day all over the world to place too great a reliance on radiographs and laboratory tests, much to the disadvantage of the young clinician. The ancillary aids are important, but should be used to confirm a clinical diagnosis and not to make it.

Teachers of clinical surgery have much to thank Mr. Hamilton Bailey for, and, not the least, is this excellent volume on demonstrations of physical signs in clinical surgery.

BOOK NOTICES

[*The Editorial Committee acknowledge with thanks the receipt of the following volumes. A selection will be made from these for review, precedence being given to new books and to those having the greatest interest to our readers.*]

Local Analgesia: Brachial Plexus. By R. R. MACINTOSH, M.A., D.M., F.R.C.S., F.F.A.R.C.S., D.A., Nuffield Professor of Anæsthetics, University of Oxford; and WILLIAM W. MUSHIN, M.A., M.B., B.S. (Lond.), M.R.C.S., F.F.A.R.C.S., D.A., Professor of Anæsthetics Welsh National School of Medicine, University of Wales. Third edition. 7⅜ × 4¾ in. Pp. 62, with 32 illustrations. 1954. Edinburgh: E. & S. Livingstone. 10s. 6d.

Any Questions. A Selection of Questions and Answers published in the *British Medical Journal*. Third Series. 7¼ × 4⅞ in. Pp. 227 + xvi. 1954. London: British Medical Association. 7s. 6d.

A Study of the Deaths associated with Anæsthesia and Surgery. Based on a study of 599,548 anæsthesias in 10 institutions, 1948–52, inclusive. By HENRY K. BEECHER, M.D., and DONALD P. TODD, M.D., Harvard Medical School and Massachusetts General Hospital. *No.* 254 *American Lecture Series*. 8½ × 5½ in. Pp. 66 + xiv. 1954. Springfield, Ill.: Charles C. Thomas. (Oxford: Blackwell). 20s.

Maladies des Os et des Articulations. By STANISLAS DE SÈZE, Associate Professor in the Faculty of Medicine of Paris; Physician to the Hospital Lariboisière, and ANTOINE RYCKEWAERT, Assistant Physician to the Paris Hospitals. 9 × 6¾ in. Pp. 1218, with 391 illustrations. In loose-leaf binder for annual revision. 1954. Paris: Editions Médicales Flammarion. 9300 fr.

The Nuffield Foundation. Report for the Year ended 31 March, 1954. 8½ × 5½ in. Pp. 141. 1954. Oxford: The University Press.

The Nuffield Foundation. Report on Grants made during the Ten Years April 1943 to March 1953. 8½ × 5½ in. Pp. 319. 1954. Oxford: The University Press.